

TRANSACTIONS
OF THE
American Fisheries Society

**FIFTY-FIFTH ANNUAL MEETING
DENVER, COLORADO
AUGUST 17, 18, 19, 1925**

**Published Annually by the Society
HARTFORD, CONNECTICUT
1925**

American Fisheries Society

ORGANIZED 1870

INCORPORATED 1910

Officers for 1925-1926

<i>President</i>	CHARLES O. HAYFORD, Hackettstown, N. J.
<i>Vice-President</i>	JOHN W. TITCOMB, Hartford, Connecticut.
<i>Secretary</i>	CARLOS AVERY, New York City.
<i>Treasurer</i>	T. E. B. POPE, Milwaukee, Wis.
<i>Librarian</i>	JOHN W. TITCOMB, Hartford, Conn.

Vice-Presidents of Divisions

<i>Fish Culture</i>	FRED J. FOSTER, Missouri.
<i>Aquatic Biology and Physics,</i>	DR. H. S. DAVIS, Washington, D. C.
<i>Commercial Fishing</i>	LOUIS R. RADCLIFFE, Washington, D. C.
<i>Angling</i>	JOHN P. WOODS, St. Louis, Missouri.
<i>Protection and Legislation</i>	LEE MILES, Little Rock, Ark.

Executive Committee

DR. EMMELINE MOORE, <i>Chairman</i>	Albany, N. Y.
E. LEE LECOMPTE	Baltimore, Maryland.
J. A. RODD	Ottawa, Canada.
G. C. LEACH	Washington, D. C.
W. E. ALBERT	Des Moines, Iowa.
WM. M. KEIL	Boise, Idaho.
J. B. DOZE	Pratt, Kansas.

Committee on Foreign Relations

WM. C. ADAMS, <i>Chairman</i>	Boston, Mass.
HONORE MERCIER	Quebec, Canada.
W. J. STRATTON	Springfield, Illinois.
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Committee on Relations with National and State Governments

NATHAN R. BULLER, <i>Chairman</i>	Harrisburg, Penn.
J. A. RODD	Ottawa, Canada.
HENRY O'MALLEY	Washington, D. C.
I. T. QUINN	Montgomery, Alabama.
R. G. PARVIN	Denver, Colorado.

PRESIDENTS' TERMS OF SERVICE AND PLACES OF MEETING

The first meeting of the Society occurred December 20, 1870. The organization then effected continued until February, 1872, when the second meeting was held. Since that time there has been a meeting each year, as shown below. The representative presidents were elected at the meeting, at the place, and for a period shown opposite their names, but they presided at the subsequent meeting.

1. William Clift	1870-1872	New York, N. Y.
2. William Clift	1872-1873	Albany, N. Y.
3. William Clift	1873-1874	New York, N. Y.
4. Robert B. Roosevelt	1874-1875	New York, N. Y.
5. Robert B. Roosevelt	1875-1876	New York, N. Y.
6. Robert B. Roosevelt	1876-1877*	New York, N. Y.
7. Robert B. Roosevelt	1877-1878	New York, N. Y.
8. Robert B. Roosevelt	1878-1879	New York, N. Y.
9. Robert B. Roosevelt	1879-1880	New York, N. Y.
10. Robert B. Roosevelt	1880-1881	New York, N. Y.
11. Robert B. Roosevelt	1881-1882	New York, N. Y.
12. George Shepard Page ..	1882-1883	New York, N. Y.
13. James Benkard	1883-1884	New York, N. Y.
14. Theodore Lyman	1884-1885	Washington, D. C.
15. Marshall McDonald	1885-1886	Washington, D. C.
16. W. M. Hudson	1886-1887	Chicago, Ill.
17. William L. May	1887-1888	Washington, D. C.
18. John Bissell	1888-1889	Detroit, Mich.
19. Eugene G. Blackford ..	1889-1890	Philadelphia, Pa.
20. Eugene G. Blackford ..	1890-1891	Put-in Bay, Ohio.
21. James A. Henshall	1891-1892	Washington, D. C.
22. Herschel Whitaker	1892-1893	New York, N. Y.
23. Henry C. Ford	1893-1894	Chicago, Ill.
24. William L. May	1894-1895	Philadelphia, Pa.
25. L. D. Huntington	1895-1896	New York, N. Y.
26. Herschel Whitaker	1896-1897	New York, N. Y.
27. William L. May	1897-1898	Detroit, Mich.
28. George F. Peabody	1898-1899	Omaha, Nebr.
29. John W. Titcomb	1899-1900	Niagara Falls, N. Y.
30. F. B. Dickerson	1900-1901	Woods Hole, Mass.
31. E. E. Bryant	1901-1902	Milwaukee, Wis.
32. George M. Bowers	1902-1903	Put-in Bay, Ohio.
33. Frank N. Clark	1903-1904	Woods Hole, Mass.
34. Henry T. Root	1904-1905	Atlantic City, N. J.
35. C. D. Joslyn	1905-1906	White Sulphur Springs, W. Va.
36. E. A. Birge	1906-1907	Grand Rapids, Mich.
37. Hugh M. Smith	1907-1908	Erie, Pa.
38. Tarleton H. Bean	1908-1909	Washington, D. C.
39. Seymour Bower	1909-1910	Toledo, Ohio
40. William E. Meehan	1910-1911	New York, N. Y.
41. S. F. Fullerton	1911-1912	St. Louis, Mo.
42. Charles H. Townsend ..	1912-1913	Denver, Colo.
43. Henry B. Ward	1913-1914	Boston, Mass.
44. Daniel B. Fearing	1914-1915	Washington, D. C.
45. Jacob Reighard	1915-1916	San Francisco, Calif.
46. George W. Field	1916-1917	New Orleans, La.
47. Henry O'Malley	1917-1918	St. Paul, Minn.
48. M. L. Alexander	1918-1919	New York, N. Y.
49. Carlos Avery	1919-1920	Louisville, Ky.
50. Nathan R. Buller	1920-1921	Ottawa, Canada.
51. William E. Barber	1921-1922	Allentown, Pa.
52. Glen C. Leach	1922-1923	Madison, Wis.
53. George C. Embody	1923-1924	Quebec, Canada.
54. Eben W. Cobb	1924-1925	Denver, Colo.

*A special meeting was held at the Centennial Grounds, Philadelphia, Pa., October 6 and 7, 1876.

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PART 1
BUSINESS SESSIONS

PROCEEDINGS
of the
American Fisheries Society
FIFTY-FIFTH ANNUAL MEETING
at
DENVER COLORADO
August 17, 18, 19, 1925

The Fifty-fifth Annual Meeting of the American Fisheries Society convened at the Brown Palace Hotel, Denver, Col., on Monday, August 17, 1925, at 10:30 a. m., President Eben W. Cobb in the Chair.

First Session, Monday Morning, August 17.

REGISTERED ATTENDANCE

HORACE G. FRANTZ, Fish Culturist, Colorado Springs, Colo.
C. P. PETERSON, Game and Fish Commissioner, Bisbee, N. D.
G. M. WILLARD, State Game Warden, Phoenix, Ariz.
EBEN W. COBB, Field Supervisor, State Board of Fisheries and Game, Hartford, Conn.
ROLAND G. PARVIN, State Game and Fish Commissioner, Denver, Colo.
JNO. P. WOODS, Delegate at Large, St. Louis, Mo.
EMMELINE MOORE, Investigator in Fish Culture, Albany, N. Y.
J. W. TITCOMB, Board of Fisheries and Game, Hartford, Conn.
R. R. ROUSSEAU, Chief Assistant, Game and Fish Commission, Cheyenne, Wyo.
GUY AMSLER, Sec., Game and Fish Commission, Little Rock, Ark.
LEE MILES, Chairman, Game and Fish Commission, Little Rock, Ark.
JAMES A. LAIRD, South Side Sportsmen's Club, Oakdale, N. Y.
W. M. KEIL, Idaho Fish Commission, Boise, Idaho.
HERMAN Q. HESEN, Supt. U. S. Fisheries Station, Fairport, Iowa.
THOMAS K. CHAMBERLAIN, Director, U. S. Fisheries Station, Fairport, Iowa.
D. C. BOOTH, U. S. Bureau Fisheries, Spearfish, S. D.
T. SURBER, Supt. Fish Propagation, St. Paul, Minn.
M. S. CARPENTER, Secy. Montana Sportsmen's Association, Missoula, Mont.
WILLIAM C. ADAMS, Director Massachusetts Fish and Game, State House, Boston.
CHAS. O. HAYFORD, Hackettstown, New Jersey.
E. LEE LECOMPTE, Baltimore, Maryland.
CARLOS AVERY, (Ex. Secy.) New York City, N. Y.
D. E. PETTIS, Dep. Warden, Arizona.
J. M. MURPHREE, Pratt, Kan.
J. W. CONNELLY, Denver.

- C. WALLICH, Utah.
 C. F. CULLER, U. S. Fisheries, Homer, Minn.
 SETH M. AINSWORTH, Fisheries Station, Saratoga, Wyo.
 ROBERT D. MILLIKEN, No. Dighton, Mass.
 WILLIAM J. STRATTON, Director of Conservation, Springfield, Ill.
 FRED J. FOSTER, Bureau of Fisheries, Neosho, Mo.
 J. H. BRUNSON, Louisville, Neb.
 JOHN P. BENGARD, Supt. Fisheries, Valley Ranch, New Mexico.
 T. P. DELGADO, Game Warden, Sante Fe, N. M.
 E. C. YOUNG, Debates Office, House of Commons, Ottawa, Canada.
 C. H. VAN ATTA, Leadville, Colo.
 JOHN B. BURNHAM, American Game Protective Association, New York,
 N. Y.
 GEO. A. TOMERAASEN, Bureau of Fisheries, Distribution Car No. 8.
 G. C. LEACH, Washington, D. C.
 W. T. THOMPSON, Supt. Fisheries Station, Bozeman, Mont.
 W. E. ALBERT, Des Moines, Iowa.
 CHAS. PAYNE, Wichita, Kansas.
 DR. F. S. RISER, Com. Trout Grower, Henderson, Colo.
 W. A. KING, Brownsville, Texas.
 ROGER W. TOLL, Rocky Mountain National Park, Estes Park, Colo.
 SETH E. GORDON, Ex. Secy. Pa. Game Commission, Harrisburg, Pa.
 E. F. AVERILL, State Game Warden, Portland, Oregon.
 A. R. REEVES, State Game and Fish Warden, Oklahoma City, Oklahoma.
 C. W. KELLY, Educational Director, State Fish and Game Commission,
 Claremore, Okla.
 F. J. HILL, State Secy. Izaak Walton League, Oklahoma City, Okla.
 FRANK COOK, Hatchery Supt. Laramie, Wyo.
 GEO. C. WAGGONER, Executive Fish and Game Department, Frankfort,
 Ky.

NEW MEMBERS ELECTED.

- SPEARFISH CHAPTER No. 1, Izaak Walton League of America, Spearfish,
 South Dakota.
 RAYMOND ZINKY, Colorado Springs, Colo.
 ROBERT D. MILLIKEN, North Dighton, Mass.
 M. S. CARPENTER, Missoula, Montana.
 R. R. ROUSSEAU, Cheyenne, Wyo.
 HENRY HANSON, Lanesboro, Minn.
 WM. CHRISTIANSON, St. Paul, Minn.
 CLAUDIUS WALLICH, Springhill, Utah.
 C. P. PETERSON, Bisbee, N. D.
 J. M. MURPHREE, Pratt, Kan.
 JOHN P. BENGARD, Valley Ranch, New Mexico.
 FRED H. DOELLNER, Winona, Minn.
 JOHN B. BURNHAM, New York.
 C. H. VAN ATTA, Leadville, Colo.
 T. P. DELGADO, New Mexico.
 WILLIAM SCOTT, Colorado.
 WALTER C. BUCKMASTER, Bozeman, Mont.
 SNAKE KING (W. A. KING), Brownsville, Texas.
 A. R. REEVES, State Game Warden, Oklahoma.
 F. J. HILL, Oklahoma City.
 CHARLES PAYNE, Naturalist, Wichita, Kan.
 I. T. QUINN, Montgomery, Ala.

A. A. SANDERS, Wyoming.
JAMES J. FAYE, Denver, Colo.

Mr. Benjamin F. Stapleton, Mayor of Denver, was introduced by Commissioner Roland G. Parvin, and made an address of welcome, which was responded to by Colonel John P. Woods.

Guy Amsler of Little Rock, was elected Treasurer pro tem.

PRESIDENT COBB: The order of business calls for a report from the President at this stage. I have no formal report to present. I have carried on some correspondence and transacted what business it was necessary for me to transact. A formal report would take time and be of no particular service.

REPORT OF THE SECRETARY.

MR. CARLOS AVERY: Mr. President, I have not written a report, but there are a few matters I wish to mention informally. I was elected Executive Secretary at the last meeting in Quebec without my knowledge or consent. After being elected I tried to ascertain what the duties of Executive Secretary were. I found there were no duties prescribed in the constitution, but following the instructions of the President I tried to do what came to hand.

Those of you who have received the copies of the Transactions of the last annual meeting received them only during the last few days. That delay was unfortunate; I believe the Transactions should be issued promptly after the meeting and sent to members while the memory of the meeting is still fresh in the minds of those who attended, and so that those who did not attend may get the benefit of the information before it becomes stale. The reason for the delay was that the last meeting created, or directed the President to create, a committee for editing the Transactions. Mr. Cobb found a great deal of difficulty in getting such a committee. Having distributed the papers among those who served in that capacity he was unable to get them back, so that no papers at all came into my hands until the early part of the summer, months after the meeting. Then, as to the printing, of the Transactions, you may realize that the Society is poor and that the saving of a dollar where it can be saved is a very necessary thing. I was advised by the treasurer that we could spend only a certain amount of money. I procured estimates on the publishing of the Transactions and found that we could not get them printed and include anywhere near all the proceedings except at the State Reformatory in Connecticut, which Mr. Titcomb kindly consented to have done. He saved the Society a dollar a page. During the summer the foreman of the printing plant where this work was done was ill for a long time and the work was held up awaiting his

return to his duties. On account of these delays we were barely able to get the proceedings out before this meeting.

If I might make a suggestion, I think that the editing of these papers should be done promptly, at the meeting and immediately thereafter, so that they can be put in the hands of the printer within a very short time and the book issued while the material is as fresh as possible.

It should also be the function of the secretary to campaign for new members. Our great weakness is in the lack of new material coming in to take the place of the members who drop out. I have not done much of that except incidentally. At the last annual meeting twenty-three names were added to the roll, and during the past year there have been twenty-nine more, including one life membership, one state membership and two dealers. No clubs have joined during the past year. The gross increase in membership last year was fifty-two.

There should be some provision made for the secretary to carry on constantly an aggressive campaign for membership. It is pitiful that the society has such a small number of members. The great service it renders to the fisheries of America entitle it to a large membership. There are sportsmen, anglers, officials, clubs, dealers and many others throughout the country who undoubtedly would be glad to join the Association if the matter was brought to their attention in an earnest way.

Prior to this year no one has served especially as librarian; the constitution provides for no such office. But during the past year Mr. Titcomb very kindly consented to retain charge of the archives and publications of the Society, keep them in order and try to arrange them in such a way that they would be accessible; also to supply copies of our publications ordered by those who wish to purchase them. Mr. Titcomb has rendered valuable service in doing this, and provision should be made for a permanent librarian of the Society.

I might point out that the constitution has not been revised or brought up to date for a great many years. It is incomplete, ambiguous in some respects and out of date, and it would be one of my suggestions that provision be made here at this meeting for its revision in order to clarify it and specify the duties of the officers. The constitution gives a list of officers but prescribes no duties for any of them, so that there is sometimes doubt on the part of the officers whether they have any duties to perform at all. There is no provision as to how the permanent fund shall be invested and safeguarded. As a matter of fact these funds are in the hands of the treasurer, in a savings bank, and are properly taken care of, but there is no direction in the constitution to guide him. There are a number of other things that ought to be covered by the constitution but which are not provided for. A committee, if selected at this meeting could easily ascertain these matters by a careful reading of it.

The matter of auditing claims which are paid by the treasurer is not provided for. The treasurer pays the accounts as they come to him if

he believes they are proper. The matter of the reinstatement of delinquent or dropped members is another thing which is entirely indefinite. A member who drops out may remain out for a time and then make fresh application as a new member, and although owing a large amount of dues is accepted.

The report of the secretary was accepted.

REPORT OF THE TREASURER

Herewith is submitted the annual report of the Treasurer covering the period from September 1924 to August 8, 1925, inclusive.

During the past fiscal year of the Society there has been a considerable falling off of the revenue as compared to the preceding year, this difference being due to the lack of substantial funds derived from life memberships, donations and the sale of publications. Despite this reduced income however it is noted that the Society has not only met all of its current financial obligations promptly but has been able to restore a small amount to the Permanent Fund. While this amount deposited in our savings account towards the refunding of the withdrawals made several years ago is not large as was hoped for yet it may be interpreted as an encouraging sign for the future. The writer is firmly convinced that any continued financial stability of the Society, as to annually meeting all of its obligations or restoring further funds to the Permanent Fund, can only be accomplished by constant and continued cooperation and understanding between the principal officers that are lawfully responsible for the contracting of financial obligations.

The attention of the members is again called to the necessity of paying their dues regularly and promptly. It is only through the payment of membership dues that the Society obtains funds for the printing of its publications and operating expenses. There is still too large a percentage of delinquent members in this respect. The Constitution allows the Treasurer the right to drop members from the list that are delinquent for two years but no one has been dropped by the writer for a period of less than three years. Despite this extension of time the number annually dropped is too great and could be considerably reduced if each individual member would "pay up" promptly before the official appeal for dues was forgotten.

In this connection it is regretted that the present regulations of the Society do not allow for the retention on the rolls of the very few older members that openly admit they are unable to pay their dues and yet who, after their long association with the Society, should be retained if it is possible to do so. The number of such members is fortunately very few. If it is possible, the Society could well afford to enact such legislation as would authorize the Treasurer to grant exemption of annual dues to these worthy members of 25 years good standing, it being understood of course that any such individual exemption would be offi-

cially approved by the President and Secretary also. When we consider that our regulations allowed the granting of life-memberships in the past for only \$25.00, which fee now covers only eight and one-third years of present active membership computed at \$3.00 per year, and that more than one-half of our roster of 44 life-members is carried now as an actual "dead loss" to the Society, then the granting of exemption of dues to the very few old members who have loyally stood by the Society and paid regularly for 25 years can hardly be termed as a discrimination or financial risk. On the contrary, such exemption would have been only merited and but common justice.

The following items are now presented for your consideration:

GENERAL FUND.

Receipts

Balance on hand at meeting of 1924		\$ 19.14
Annual Dues		
Individual and Libraries		
For the year 1921	\$ 3.00	
For the year 1922	14.00	
For the year 1923	45.38	
For the year 1924	1,069.60	
For the year 1925	56.12	
Clubs and Dealers		
For the year 1924	120.00	
State Memberships		
For the year 1924	140.00	
Life Memberships	75.00	
Sale of Publications	53.75	
Donations	5.00	
		1,581.85
Total Receipts		\$1,600.99

Disbursements

1924 Meeting at Quebec, Canada,		
Reporting proceedings of	\$260.00	
Printing programs for	6.56	\$266.56
Transactions, 1924, Vol. 54,		
Postage for	75.00	75.00
Expenses of Secretary's Office,		
Printing of stationery, applications		
and circulars	37.81	
Postage	34.70	
Clerical assistance	100.00	172.51

Expenses of Librarian,			
Postage	5.66	5.66	
Expenses of Treasurer's Office,			
Printing bills and envelopes	41.50		
Postage and supplies	16.10		
Clerical Assistance	50.00	107.60	
Membership Refunds	3.00	3.00	
Transferred to Permanent Fund	369.74	369.74	
			1,000.07
Balance on hand			\$ 600.92
Bill for Printing Transactions of 1924, received too late to include in report,			516.25
Net balance,			\$ 84.67

PERMANENT FUND

Receipts

Balance on hand at meeting of 1924		\$1,741.38
Interest to June 1, 1925	\$ 52.61	
By transfer from General Fund July 27, 1925 on account refund	369.74	422.35
Total		\$2,163.73

Disbursements

	0.00
Balance on hand	\$2,163.73

MEMORANDUM

Owing to the late issuance of the annual volume of Transactions no bills for the cost of printing of the same had been received by the Treasurer up to the date of the preparation of this report. It is believed that the printer's bill is the only outstanding current obligation and that sufficient funds are on hand to meet such expense.

In the annual report of the former treasurer, A. L. Millett, dated September 12, 1923, the balance due the Permanent Fund was reported as \$1,369.74. The refunding of the item of \$369.74 shown above leaves an even deficit of \$1,000, plus interest, to the fund. This amount can

be probably repaid in several years if the revenue of the Society does not materially lessen or our expense too heavily increase.

Respectfully submitted

T. E. B. POPE,

Treasurer.

The report was accepted and referred to the Auditing Committee.

REPORT OF THE LIBRARIAN

MR. JOHN W. TITCOMB: I have enough volumes of old Transactions to make half a box car load. In a circular letter accompanying the last Transactions I gave a list of volumes which are available for sale as well as a few volumes which we really need to complete our files. The Society has not a complete set. These volumes are growing more valuable as time goes on. We have occasional calls for the older volumes. I had a call for two the other day and was able to furnish only one of them. If anyone knows where there are any of the old volumes available and will contribute them to the Society or turn them over at dealer's prices, he will confer a favor. The issues we lack are those of 1873, 1874, 1875, 1877, 1894, 1899, 1905.

We have a great many surplus quarterlies of some issues, and of others there are only a few copies. These odd quarterlies are of no particular value unless someone wants to read some of the papers appearing in them. In the circular to which I have referred I gave a list of the odd quarterlies, with the titles of the papers, in case some people might want to acquire them at a price of ten cents a copy.

We have about 570 members, including commissions and life members—there are 44 life members, I believe. I want to supplement the secretary's remarks about memberships. Commissions in some instances cannot join as such and have the fee paid out of the state treasury, owing to the provisions of the state laws. Last year when I was secretary we found that some of the commissions, while not being able to join, could buy five, ten or twenty copies of the Transactions and distribute them among their different employees, in that way helping along our treasury and practically doing the same thing as if they joined as a commission. Possibly there are some commissioners here who could subscribe for some of these copies, which are really valuable. You do not pay anything for the writing of these papers by experts; you pay a little more than the cost of printing them, and they are well worth having in libraries. I may say that libraries throughout the country are becoming very much interested in these publications and are making calls for back numbers. Some of the libraries are on our regular mail-

ing list now, and they pay the same price for a volume as you pay for a membership fee.

I believe that the library should be kept in one place in the custody of a permanent librarian. I am not a candidate for the job. When this library came to me it came by express at an expense of \$45. I have had my office boy spend all his spare time in the basement trying to get this stuff into shape. Of course an intelligent person who had the time could have put it in shape very soon, but the boy rather enjoyed spending his time in the basement sorting the volumes out, and got them in pretty fair shape. One of our fellow sportsmen made \$50 or \$75 worth of boxes so arranged that they could be put up in the form of book cases, and I have one of our basement storerooms lined all around with these cases reaching from floor to ceiling, with covers on them and labels as to the contents; and they are so arranged that I can get at any particular volume when it is wanted. Since I am so situated that I can have all this work done at no expense to the Society, I shall be glad to take care of the stuff for you. (Applause.)

PRESIDENT COBB: I am sure the Society is very thankful to Mr. Titcomb for the great amount of work he has done in taking care of this library.

REPORT OF THE VICE PRESIDENT DIVISION OF FISH CULTURE

EMMELINE MOORE

N. Y. State Conservation Commission

The trouble with a report on the status of fish culture is that no one person can cover the entire field and give a sympathetic account of its many sided activities in a few minutes. So it occurred to me it might be useful to have a few facts in handy packets that we might see how we fare in means to make progress.

In the broad field of fish culture I marked off a portion for inquiry that should have especial bearing on our common problems in scientific study; to find out how we are meeting them and whether our means seem adequate for the future.

Forthwith there went out a questionnaire to the Commissioner of Fisheries in all the states, to Canada and to Mexico. The answers came back sooner than the most optimistic could expect and they form the basis of this report. The questions have inspired so much enthusiasm—one man said he “could write a book on ’em”—that the replies do not lend themselves readily to tabulation. So at the expense of some weariness on your part I will give them in the form of summaries.

Question 1. What are your sources of revenue for investigation and research? Have you a provision by statute whereby money derived from fish and game licenses may be used for this purpose?

Twenty-five states derive in part their revenues from licenses and fees. Ohio and New York swung into line only this year. Maryland and Wyoming are developing sentiment toward this end. In 11 states and in Canada the revenue reverts directly to the Commonwealth. Nine states have not reported. In states where license moneys are credited to the Commission, there is given discretionary power in the use of them for scientific studies. It seems, therefore, since the language cannot be construed as opposed to such procedure, there is an available source not yet applied to this end. In New York, the Conservation Fund and in Pennsylvania, the Fish License Fund expressly stipulate that revenues may be used for scientific studies.

Question 2. What legislation in the interest of the fisheries did you succeed in passing this year?

Seventy-two per cent of the states reporting legislated favorably, covering the following items: To construct more hatcheries, to reduce the bag limit, to extend the close season, to prohibit the sale of game fish, to give discretionary power to the Commissioner, to provide more adequate license systems, and to provide for the recodification of fishing laws.

A new fish code enacted by Pennsylvania prohibits all manner of fishing in the inland waters, excepting with rod, hook and line. New York, after years of effort, succeeded in enacting a law combining fishing, hunting and trapping licenses and established what is known as the Conservation Fund. This fund shall consist of one-half of the moneys received from licenses for hunting, trapping and fishing. It should bring in revenues approaching \$400,000.00 annually, and though it is freighted with "interests" economic and expedient, which will crowd the purely scientific aspects, it should provide an entering wedge for a broad program of study with ample funds for continuity.

In Connecticut there was created a new Commission of Forests and Wild Life, constituted from the State Park and Forest Commission and the State Board of Fisheries and Game; in Illinois, the Department of Conservation was formed which takes over the former Division of Game and Fish, and adds the Division of Reforestation and Stream Pollution. In Kansas, a Forestry, Fish and Game Commission was created; in Florida, the Department of Game and Freshwater Fish.

This represents an inspiring array of fisheries legislation and illustrates how surely, though slowly, the idea of better fisheries conservation is gripping the public mind.

Question 3. How are you providing for fish sanctuaries? What areas are devoted to them?

Eleven states only are moving forward in this direction. The definition of a fish sanctuary, covering rather wide limits, may be interpreted

to mean any or all of the various projects defined by these states below. I list them as instructive examples.

The establishment of breeding areas in Great Ponds, as in Massachusetts and Iowa; the use of impounded waters for brood stock, as in Maryland; the use of municipal water supply reservoirs for distribution centers, as in Connecticut; the closure of small tributaries and sections of lakes for breeding grounds, as in Vermont, Minnesota, Ohio, Oregon, Texas, Indiana, New Mexico and New York. By referendum vote in California the Klamath river was saved from spoliation for power purposes and set aside for a fish preserve.

In Canada, "the area varies from year to year. Upper waters of streams are closed to all fishing for definite periods when they are the nurseries for young fish. Fishing limits at the mouths of rivers are moved in or out as conditions demand. In a few instances, small but important spawning grounds in lakes are permanently closed to fishing." And from the Yukon comes the delightfully cheering report—"The lakes and rivers abound with fish and so far it has not been necessary even to establish hatcheries." We have nothing so Utopian as this. We are learning almost too late in our fisheries that "the principle of sanctuary is the most valuable lesson in modern conservation."

Question 4. What promising projects in the fisheries have you under way?

The returns show a variety of activities. In 21 states the following projects are under way:

1. Stream or lake surveys in Connecticut, Maine, Michigan and Minnesota.
2. Salt water fisheries investigation in Texas.
3. Studies of fish diseases in New York and New Jersey.
4. Propagation of shad in Connecticut.
5. Rescue work in Nebraska and Connecticut.
6. Construction of hatcheries and ponds in 21 states two of which, Alabama and Florida, are constructing their first hatcheries this year.

Question 5. What is your program for stocking large areas of impounded waters made available by power projects?

The outstanding projects are two in number,—Lake Herrington in Kentucky and Deep Creek in Maryland. Since several other giant dams are in progress of construction, I thought it worth while to call attention to this feature which promises important results for the future.

Lake Herrington, formed by the Great Dix Dam, is just filling, impounding water for a great lake 36 miles long, $\frac{1}{2}$ – $\frac{3}{4}$ of a mile wide and 200 ft. deep for a distance of 15 or 20 miles. According to Mr. Meredith, the Superintendent of Wardens, this new deep lake will be stocked with lake trout. It represents one of the finest opportunities I know of testing experimentally, under quite ideal conditions, the adaptive possibilities of the lake trout and, let us say, one of the deep water

white fishes which should serve as its natural food. The recorded history of progress of a definite stocking policy in such a new, deep lake offers one of the finest fields for a big contribution to our knowledge of fish culture.

The Deep Creek project of Maryland is of no less importance. According to Mr. Earle, Commissioner, this lake, formed by a dozen mountain streams already stocked with brook trout, forms the greatest rainbow and brook trout lake in the country. The lake formed by this project extends over an area of eleven miles in length with an average width of one-half to one mile, and covers 4,300 acres with a channel 60 feet deep. The state, from this lake, expects to reap a valuable harvest of spawn from its own fish.

Question 6. Have you a workable pollution law?

From 12 states came the unequivocal answer, no! From 10 states and Canada, "Fair to middling." One state was non-committal, and another had no law on the statutes.

Without attempting to make a black list and a white list, I have set up in this map in quite arbitrary fashion a classification of states, those in black which are apparently marking time and those in white which are showing progress in certain directions. I must add that in many cases I have not seen the laws to study them but have taken the report of the commissioner answering the questionnaire. We may assume then that these states in black are suffering under pollution laws that are vague and weak, expressed in the most general terms, leading to inexactness and confusion; and those in white as indicating the direction in which progress lies. Let us examine them.

In California, it is reported that pollution by mining wastes and sawdust have been stopped. So far so good.

In Colorado, the courts render a decision after considering the importance of the industry causing the pollution and the importance of the stream as a fish supply. There is in this a candid recognition of the fact that a stream may have many legitimate uses, and that pollution so-called may be legitimate or may represent abuse of a legitimate use.

In Connecticut a new law goes into effect creating a State Water Commission clothed with authority to investigate conditions and to exercise wide regulating powers.

In Illinois the U. S. Government has given notice to Chicago, which for 25 years has shunted its raw sewage into the Chicago river, that this practice is not in conformity with modern ideals, and that it shall within the next five years construct such sewage disposal works as will prevent the diversion of excessive amounts of water from Lake Michigan required at present to dilute its raw wastes sufficiently to carry them down the Chicago and Illinois rivers. Meanwhile "watchful waiting" is the policy of industry regarding the disposal matters in that state pending settlement of the controversy. Yet the stand the Government has tak-

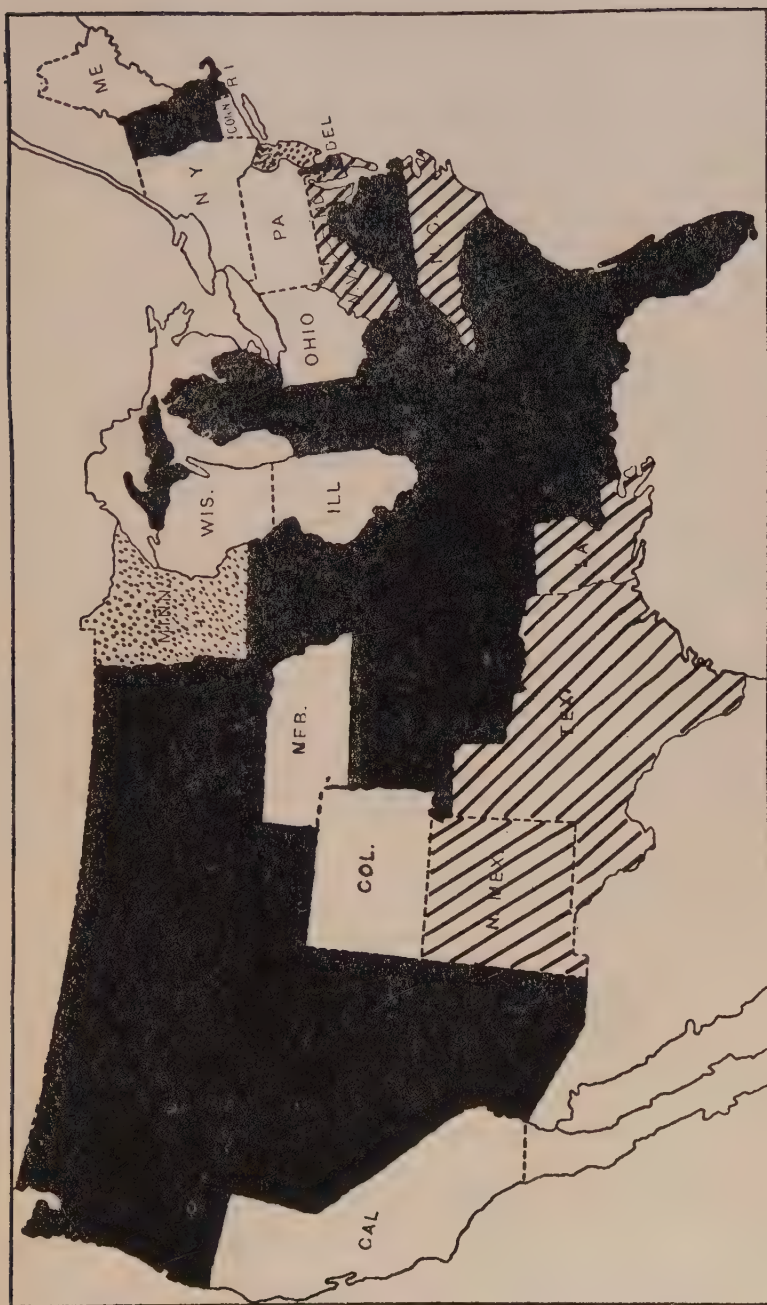


Fig. 1. Map showing general status of pollution laws as related to the fresh water fisheries. States in "white," studying effects of pollution or operating under new laws carrying decidedly progressive features; States in "black," operating under weak laws with little or no relief; States with "crossbars," indicate satisfaction with their pollution law; States "dotted" have authorized preliminary study of the question.

en that it is not a proper procedure to dump raw sewage into any water, will carry tremendous weight and should react favorably both in the interest of health and of the fisheries.

In Maine a new law authorizes the Fish and Game Commission in conjunction with the State Forest Commission to promulgate regulations prohibiting the pollution of streams upon petition of 25 citizens at a public hearing. This is also a step, though a small one, in the right direction. In Maryland, New Mexico, Texas, North Carolina and Louisiana the replies denote satisfaction.

In Minnesota, New Jersey, Ohio and Wisconsin, the states are studying the question or operating under a new law passed this year.

In Nebraska a permit to pollute is required from the Department of Agriculture. If well regulated that might be helpful, but as it stands it is not a forward looking program.

In New York, we have a weak law. We have, however, given the subject considerable scientific study and have formulated a set of standards or indicators of a sort which are of material assistance to our protective forces. Our legislative branch, on recommendation of the Conservation Commission, is also studying the question of administrative policy for the future.

In Pennsylvania, definite restrictive measures have been brought about under a provision granted by the Legislature to classify its streams:

Into, Class "A" streams which shall remain relatively clean and pure;
Class "B" streams in which pollution shall be controlled; and
Class "C" streams, "Beyond the pale" so to speak.

It represents the longest step forward taken by any of the states thus far. The organization of the Sanitary Water Board and its broad comprehensive program are set forth in detail in the last number of the Transactions where it is available in convenient form to all members of the society.

Summarizing from the "white list" we note that definite progress is indicated along the following lines:

1. In the effort to derive standards or limits of allowable pollution.
2. In the recognition of what constitutes legitimate use or abuse of a given stream.
3. In the establishment of some Board or Commission with wide powers of regulation and control to enable it to investigate and to allocate different waters for different purposes.

Question 7 and 8. Have you a biologist on whole or part time who is working on fisheries problems? Are you affiliated with any scientific agency, state or federal, whereby aid may be secured in the study of such problems?

Some states are not too trustful of biologists. One commissioner said—"We never employ such a person;" another, "We don't need one." Affiliation with the U. S. Bureau of Fisheries is quite general though

13 states reported none at all. In 9 states there is connection established between the Fish Commission and the State University or some other institution of higher learning. This seems a most promising relationship and one which should be more generally fostered.

Some time, before very long, let us hope that a thorough study will be made of ways and means of better articulating fisheries investigations into the curricula of our great laboratories of natural science. Professors no longer look upon our problems as "tainted" because they are practical, yet as matters stand we cannot fit in the work without adding materially to burdens of an already overloaded program.

Question 9. Are your hatchery superintendents required to possess any scientific training? What is the salary scale of the hatchery personnel?

Two states have a requirement of scientific training, Oregon and Alabama. The consensus of opinion, however, seems to be that the best satisfaction is given by the experienced practical man, leaving the scientific end to the trained biologist. Under present conditions and with prevailing salaries this is undoubtedly true. We need, however, for the future not to lose sight of the fact that not only is quantity production sought but a high-class output.

In the matter of salaries the states differ widely, schedules varying from \$910 and home to \$1,800 and home, with an average under \$1,500. Some higher figures are reached, \$2,400 in one state; \$2,750 in another. Pretty generally, however, appropriations for these salaries are low. In some states this is serious and must be detrimental to best results.

Finally, in this brief and somewhat haphazard report, I have attempted to bring a few of our common problems to the front. It becomes obvious to all that to meet the requirements of the future we must build up a stronger public sentiment, intrench the principle of sanctuary, change the character of our pollution laws, improve the personnel and salaries, and better adapt investigational effort to our fisheries problems.

PRESIDENT COBB: It seems to me that this is one of the most valuable presentations that has been made to the Society for a long time in the matter of general information.

REPORT OF THE VICE PRESIDENT OF THE DIVISION OF COMMERCIAL FISHERIES.

J. A. PAULHUS, VICE PRES.

The activities of the Commercial Fisheries for the past year have been well maintained.

Both in Canada, and the United States, the production of sea fish shows a fair increase.

There is a fall in the catching and marketing of anadromous, and fresh water fish.

The Great Lakes yield, according to prevision will fall short considerably this season. Indications from Manitoban Lakes districts are not very promising, with a catch below the average in many spots.

Lobsters in the gulf coast are also showing acute signs of depletion.

It is yet too early to forecast the result of the salmon crop, though the species known as springs and sockeyes are under the normal yearly production. It is expected the pinks, and whites kind, will come up to expectation and make up for the deficiency.

It is evident unless there is some means of stopping the overfishing of our lakes and rivers, and of sea fish spawning in soft waters, a great loss will accrue to the fish industry before long.

Though artificial propagation has helped in a certain measure to recoup depleted areas, it has not so far proved equal to the task, and therefore has been a great disappointment to the commercial fish interest.

The suggestion of close seasons should have the support of everyone interested in the maintenance and welfare of our fish life, whether for trade, or other purposes.

The consumption of fish as a food is getting impetus, and showing admirable results.

In Canada, especially, a campaign of education and publicity inaugurated two years ago, jointly by the Federal Government, and the industry, has achieved such results, that it is to be continued for a period of at least three more years.

In the United States, at the present time, a movement is afoot to start a similar plan of advertising. The work is in the hands of the organization of U. S. Fisheries, and already the plan has passed the initial stage.

Your Vice President of the Commercial Division, and past President of the Canadian Fisheries Association has attended the annual convention of this last named institution, which was held in Halifax, N. S. the 6th, 7th and 8th of July last.

This annual meeting was largely attended, and much important business transacted. Very interesting addresses were given by Dr. Tressler of the Mellon Institute, J. J. Cowie of the Marine and Fisheries Department, Ottawa, Professor Knight of Kingston, Dr. Huntsman of the Biological Board of Canada, and J. J. Harpell of Garden Vale, director of C. F. Association. A fixed date was decided upon for the yearly celebration of the National Fish Day. Views were expressed that an International Fish Day would improve business relations.

The question of wider markets was debated thoroughly. A good deal of discussion was allowed regarding the tariffs between the two countries, as also the question of fishing privileges, and laws governing coastal navigation.

A resolution was passed urging upon federal authorities to appoint a proper qualified official, as Deputy Minister of Fisheries.

Your Vice President for the Commercial Division, has also delivered many addresses during the past year, before Boards of Trade, Chambres de Commerce, Clubs, etc., on the subject of fish as a food, and our fisheries as a national asset.

He has also accepted an invitation to be a guest of the United States Fisheries Association, at Atlantic City, N. J., and to deliver an address at the banquet of the Association the 4th of September next.

He regrets exceedingly not being able to be in Denver, Colorado, this year, but is looking forward and hopes to be present at your next convention.

APPOINTMENT OF COMMITTEES

President Cobb announced the appointment of the following Committees:

Committee to Revise the Constitution: John W. Titcomb, Chairman; Carlos Avery, Glen C. Leach.

Nominations: John P. Woods, Chairman; W. J. Stratton, E. Lee LeCompte, W. M. Keil, W. J. Foster.

Time and Place: W. E. Albert, Chairman; Dr. Emmeline Moore, Glen C. Leach.

Resolutions: Guy Amsler, Chairman; Wm. C. Adams, Lee Miles.

Program: Chas. O. Hayford, Chairman; Carlos Avery, E. Lee LeCompte.

Auditing: J. H. Brunson, Chairman; John P. Woods, H. O. Heslen.

Publications: Dr. G. C. Embury, Dr. David L. Belding.

Publicity: Roland G. Parvin.

DELEGATE TO U. S. FISHERIES ASSOCIATION.

On motion Carlos Avery was appointed to represent the American Fisheries Society at the convention of the U. S. Fisheries Association to be held at Atlantic City, N. J., in September, 1925.

REVISION OF CONSTITUTION.

The Committee to revise the Constitution submitted a report proposing a number of changes which report was adopted by a unanimous vote, there being more than fifteen members

present and voting. The Constitution as amended is included in the appendix to this volume of the Transactions.

REPORT OF AUDITING COMMITTEE.

The Auditing Committee reported having examined the records and vouchers submitted by the treasurer and found them correct and in order. The report was accepted.

RESOLUTIONS.

The following resolutions were submitted by the Committee and were adopted:

BUREAU OF FISHERIES.

Resolved, That this Society sound an alarm by petition to the Federal Government, through its budget chief, Mr. Lord, and any other proper source, of the need of better financial support for the Bureau of Fisheries, under the claim that increased appropriation will materially add to the contentment of the public generally and inspire the efforts of the talented forces of the Bureau.

PRESIDENT COBB.

Resolved, That a cordial expression of thanks be conveyed to President Cobb for his perfect devotion to the welfare of the Society during his incumbency, also to those composing his cabinet.

THE PRESS.

WHEREAS, the public press of Denver, namely, The Times, The News and The Post, have manifested an uncommon interest in the affairs of the Society;

AND WHEREAS, such manner of aid is of incalculable value in affording the best means to disseminate the doctrines here expounded;

Be it therefore resolved, That a rising vote of thanks be extended to the aforesaid publications, and to include an expression of appreciation to the respective reportorial staffs.

Resolved, That the Society extend its thanks to the management of the Brown Palace Hotel for the courtesies and conveniences afforded.

TARIFFS ON GAME BIRDS.

Resolved, That this Society, through its Secretary and officers, recommend to the United States Tariff Commission through its secretary that the present duty on imported game birds be reduced fifty per cent, and that a representative of this Society be present at the hearing before the Tariff Commission in Washington on September tenth, 1925, in support of this reduction.

DR. JAMES ALEXANDER HENSHALL

It has been said that genius is but a great devotion assiduously and intelligently plied. Certainly this describes the type of genius represented in the life and stewardship of Dr. Henshall who died at his home in Cincinnati, Ohio, April 4, 1925. He was born in Baltimore, Maryland, February 29, 1836, thus having lived to the remarkable age of 89 years. In his book, "The Book of the Black Bass," in the final paragraph, this grand old man wrote, "I feel like one who is making his last cast on a favorite pool that he will see no more forever. A pool that is endeared to him by the fondest associations. A pool whose every ripple is a smile, whose every changing mood is a look of gladness and delight, and whose steadily flowing current seems to beckon him to follow to 'The undiscovered country from whose bourn no traveler returns.'"

The American Fisheries Society loses its oldest member, the Izaak Walton League its most beloved honorary official and a hundred thousand American sportsmen a tried and valued friend. It is not doubted that Dr. Henshall was one of the most useful and devoted conservationists on the continent. He practised medicine for nearly thirty years, then entered the service of the Government as Superintendent of the United States Bureau of Fisheries at Bozeman, Montana, where he served for thirteen years, going from there to Tupelo, Mississippi, where he remained until 1917, doing similar work for the Government at the latter place. For his recorded researches in fish propagation and culture he was awarded medals at the Chicago Exposition in 1893, at the Paris Exposition in 1900 and at the St. Louis Exposition in 1904. He was President of the American Fisheries Society in 1891-92; served as secretary of the Cincinnati Society of Natural History; was President of the Montana Society of Natural Sciences and Honorary National President of the Izaak Walton League of America. He wrote many books upon the subject of fish and fishing.

Dr. Henshall lived in a period which saw the most shocking and wanton destruction of fish and game the world has ever witnessed, and with the vision of genius and the energy of the superman he sought to stay these horrible processes of ghoulish waste and slaughter. He made his impress upon the time in which he lived. He should go down in history with Walton, Roosevelt and Audubon. Personally he was gentle, loved and loving. In the memory of true sportsmen he will live, and history will record his usefulness as a heritage of generations that must know more and more the value of the ethics and decency of conservation and true sportsmanship.

REPORT OF COMMITTEE ON TIME AND PLACE

Mobile, Alabama, was unanimously selected as the place of the next meeting, the date to be the third Monday in September. The report of the committee was adopted.

REPORT OF NOMINATIONS COMMITTEE

Nominations for 1926 were as follows:

<i>President</i>	CHARLES O. HAYFORD, New Jersey
<i>Vice-President</i>	JOHN W. TITCOMB, Connecticut
<i>Secretary</i>	CARLOS AVERY, New York
<i>Treasurer</i>	T. E. B. POPE, Wisconsin
<i>Librarian</i>	JOHN W. TITCOMB, Connecticut

Vice-Presidents of Divisions:

<i>Fish Culture</i>	FRED J. FOSTER, Missouri
<i>Aquatic Biology and Physics</i>	DR. H. S. DAVIS, D. C.
<i>Commercial Fisheries</i>	LOUIS R. RADCLIFFE, D. C.
<i>Angling</i>	JOHN P. WOODS, Missouri
<i>Protection and Legislation</i>	LEE MILES, Arkansas

Executive Committee:

DR. EMMELINE MOORE (Chairman)	New York
E. LEE LECOMPTE	Maryland
J. A. RODD	Canada
G. C. LEACH	District of Columbia
W. E. ALBERT	Iowa
W. M. KEIL	Idaho
J. P. DOZE	Kansas

Committee on Foreign Relations:

W. C. ADAMS (Chairman)	Massachusetts
HONORE MERCIER	Canada
W. J. STRATTON	Illinois
THADDEUS SURBER	Minnesota

Committee on Relations with National and State Governments:

NATHAN R. BULLER (Chairman)	Pennsylvania
J. A. RODD	Canada
HENRY O'MALLEY,	District of Columbia
I. T. QUINN	Alabama
R. G. PARVIN	Colorado

The report was adopted unanimously.

REMARKS OF PRES.-ELECT HAYFORD.

PRESIDENT-ELECT HAYFORD: Ladies and Gentlemen. Making speeches is strictly out of my line, therefore I shall not attempt one at this time. This is an honor that I never expected to receive from the American Fisheries Society. It is a source of interest and pleasure to me to recall that in 1912 I was elected a member of this Society at its meeting in Denver, and I now become its President on the occasion of its next meeting in the same city. I shall endeavor to do the best I can during the ensuing year and I would ask the cooperation of the members in carrying out the work of the Society.

In Memoriam

HON. GEORGE M. BOWERS

MARC D. TAINTER

EDWARD C. WHITMAN

HAROLD SPENCER BOWER

HERBERT AUSTIN

JOSIAH KISTERBOCK, JR.

H. J. KNIGHT

ERNEST SEABORG

DR. JAMES A. HENSHALL

JOHN P. WOODS

DR. W. P. MANTON

DR. SAMUEL J. MIXTER

PART II

PAPERS AND DISCUSSIONS

THE INHIBITION OF THE SPAWNING FUNCTION OF THE SMALLMOUTH BASS BY A PARASITIC FLAT-WORM.

BY DR. EMMELINE MOORE.

N. Y. State Conservation Commission.

This paper is in no sense a report of an investigation but the announcement merely of a condition that has been observed in four different localities this season. In view of its importance to bass culture generally it seems wise in advance of investigation to call attention to the character of infection that something more may be learned, possibly at this meeting, of the prevalence of the disease and the area of distribution of the parasite.

On May 11th of this year Mr. Henry W. Beeman of the Waramaug Bass Hatchery, Connecticut, sent to me an infected bass accompanying it with the following letter: (With his permission I quote from the correspondence).

"For the past four or five years I have been carrying my brood stock of smallmouth black bass in a privately controlled lake in Putnam County, N. Y. The owner placed this lake at my disposal for the purpose of carrying an abundant supply of brood stock which at their spawning period I bring to my hatchery in Connecticut, returning them to the lake soon after for the balance of the year.

"I had hoped with this arrangement to keep our breeding bass in the best possible condition and for a time this seemed to work well. This season, however, I have discovered what appears to be a diseased condition of the bass.

"In the attempt to secure breeders for the coming season I have failed to get a single specimen that would weigh 2 lbs., though we have caught a number of bass ranging from $\frac{1}{2}$ to $1\frac{1}{2}$ lbs. On opening one of these fish I found what is evidently an abnormal growth enveloping the entire internal organs and forming an attachment to the abdominal walls of the fish. This led me to make further examination. Twelve bass ranging from $\frac{1}{2}$ to 1 lb. each were opened and all showed this condition. It may be possible that this condition may have developed in the larger fish to the point where it was fatal."

This is the end of the quotation from this letter. In a second letter dated May 18, one week following, Mr. Beeman notes that he secured a dozen large bass so it was evident that not all of the larger ones had succumbed to the disease.

From a letter of May 25th I quote the following:

"The result of the first spawning was practically a total failure. Soon after the eggs were deposited quite a large percentage of infertile eggs were noticed in each nest. These became covered with fungus which spread over the entire nest. So far as my observations go the fertility of the newly deposited eggs is very low, and in addition to the infertile eggs there seems to be a gradual dying off from day to day of those fertilized. This seems to me to indicate a run down condition of the present stock due to this parasitic attack.

"Last season about one-half million eggs were lost in the same manner, I then attributed the loss to the unusually low air and water temperature during what would have been the normal spawning period of the bass, delaying this period nearly a month. Now I am inclined to the opinion that it may have been due in part at least to the condition of the brood stock."

Mr. Beeman relates further that in all "about 30 adult bass have been sacrificed and in every single instance heavy infection was present, the examination being confined to fish from 10 inches up to 1½ lbs. in weight." The largest bass he did not kill but retained in the pond for further observation. In his recent letter under date of August 7, he notes that from these largest bass when the third spawning took place there was an unusually high state of fertility followed by a most successful hatch.

Early in the period of this correspondence I made an examination of the bass sent to me. There was disclosed a heavy infection of a parasitic flatworm of the family *Proteocephalidae*, one of the tapeworms. The worms at that date, May 13th, were immature and encysted in great numbers in all of the enveloping visceral membranes, also within the liver and spleen and scattered about in the ovary. The eggs themselves seemed not to be parasitized though many of them were abnormal in color and apparently tied up with adhesions of the cyst cases, a condition which clearly explained delayed or inhibited spawning function. No worms were found in the flesh or within the alimentary tract. The extraordinary feature of the parasitism, for so it seemed to me never having observed anything like it before, was the manner in which the internal organs were enveloped by the abnormal fibrous tissue which seemed to tie them, as it were, not only together, but to the walls of the body cavity in a quite compact mass.

Knowledge of the host stages in members of the family of parasites is quite inferential, the life histories so far as known

being based almost entirely on information of the adult, which is meagre enough. The final host bearing the adult stage of worm may be a terrestrial form, an insect, amphibian, reptile, bird or even mammal that frequents the water.

My latest information from Mr. Beeman extends the area of infection to two more lakes and the species of fish so parasitized to sun-fish as well as bass.

It may be that the incidence of infection occurs when the bass are very young. I recall that in the summer of 1920 while at work on the food requirements of the bass fry, a number of the fry were parasitized in the alimentary tract by larval worms of this family of proteocephalidae.

It was an interesting coincidence that I should receive information of a similar affliction of bass from another area of distribution, from Lake George, N. Y. On June 29th, I had this report from Dr. E. MacD. Stanton of Schenectady. I quote from his letter:

"Those of us interested in smallmouth bass fishing at Lake George have been interested and worried the past week over moderate numbers of sick and dead bass seen lying along the shore. The following data pertains to two picked up alongside my dock:

"Specimen No. 1. June 25th, large bass obviously sick seen coming to surface from time to time near dock.

"June 26th bass found floating near dock, weight approximately $3\frac{1}{2}$ lbs. Three or four scaleless areas on belly covered with fungus. On opening abdomen all peritoneal surfaces massed together by dry fibrous adhesions. The fish is a female that has apparently not yet spawned. Egg masses are mottled with small areas of hemorrhages and individual eggs are bright red, apparently due to hemorrhages into the individual eggs. Liver is soft, oily and yellowish. Lying here and there in the fibrin of the peritoneal exudate are glistening white, living, worm-like parasites, averaging about 3 c. m. in length and about one millimeter in width.

"Specimen No. 2. Ten inch male bass floating beside dock on June 26th. No evidence of fungus covered ulcers as in No. 1. Findings as to parasite same as in specimen No. 1."

Two specimens sent to me later from Lake George were parasitized in the manner above described.

I have quoted Mr. Beeman and Dr. Stanton very fully because this kind of observation affords an important element of background in further study of this parasite.

Because of the importance of this study to the culture of the smallmouth bass now and for the future, I think it ap-

propriate to make a direct appeal to the members of this society to look for further evidences of this pernicious parasite, that we may the sooner become aware of its distribution. It is important, also, to begin the study of its life history. This should be delegated to some competent biologist with a flair for worms.

BLACK BASS CULTURE.

BY DWIGHT H. LYDELL.

Asst. Supt. Hatcheries, State of Michigan.

I sincerely thought when I received your kind letter of June 11th that I would either be at the meeting or prepare a paper of some kind, but now it is too late to get out the paper, and matters that are out of my control prevent my being present. This is a disappointment to me, as I had looked forward to meeting the members once again. Please extend best wishes to them all and I surely hope you will have a successful meeting.

Our work here is progressing nicely; we have twenty-eight ponds here at the station now. All our fish are shipped as fingerlings except the surplus after all ponds are stocked for rearing.

The surplus this season was 250,000. These were shipped as advanced fry. Since then 207,000 No. 1 fingerlings have been distributed, 70,000 No. 2's have been sent out, and at the present time we are distributing No. 3's. As we have seven more ponds to seine it looks as though we would have at least 50,000 of the No. 3's. The above refers to smallmouth bass only.

Regarding the largemouth we only devoted three ponds at the station to this variety. These three ponds produced 35,000 No. 1's and 10,000 No. 2's.

Besides these three ponds we have two outside or wild ponds that are used for rearing large mouth bass to fingerling size; these ponds have an area of about $3\frac{1}{2}$ acres each.

Pond No. 1 this season has produced 39,400 No. 2 bass. Pond No. 2 we are at this time drawing and taking out the fish. So far we have distributed 35,000 from this pond and we have about 5,000 in the hatchery for shipment, and the foreman estimates that there are about 6,000 still to be collected from the pond.

We have been experimenting with these ponds for the last five years. Some seasons using the breeding fish, and other seasons collecting the fry from wild waters and putting them in the pond. Both methods have been successful, but taking the fry from the wild waters is about the easiest method. This season Pond No. 1 had 33 breeding fish put in and Pond No. 2 was stocked with fry. Taking the fry from wild waters we consider only salvaging what naturally nearly all goes to waste.

Other experiments connected with these wild ponds have been the producing of plenty of the natural food for the fry

to bring them to the fingerling stage; fertilizers used were horse manure, cow manure, and clam meal. All seemed to bring results, but the clam meal was used the most as it was the easiest to introduce, and 50 pounds seemed to bring about as good results as would a load of the horse manure.

One method used was to draw the water down until two or three feet of the shore area was exposed, leave the pond down for a couple of days, then spread the fertilizer on the exposed shore, then raise the water level to normal again. This seemed to bring on an abundance of food, such as daphnia, etc.

This same method has been tried out with the bluegills. No breeders being used, and ponds of $\frac{1}{4}$ of an acre have been giving us from 50,000 to 60,000 No. 2 fingerlings each season. These fish after they pass the fry stage have formerly been fed with clam meal exclusively. At this writing our bluegills are about an inch long, and we have started giving them ground cray-fish to one pond. This is *not* done because the clam meal has not been satisfactory in all respects, but because we have an abundance of cray-fish, and wanted to know of other foods in case needed, or others could not be procured.

The I. W. L. Chapters throughout the State are establishing some of these wild rearing ponds and we are doing all we can to bring about results.

I hope some of these notes hastily jotted down may be of interest to at least some of the bass culturists.

Discussion.

MR. FOSTER: I think perhaps I will start in on a little discussion of Dr. Moore's paper, as we have had practically the same difficulties that she has described. In the spring of 1922, after a year's work with the smallmouth, which netted nothing, we started opening up some of the fish, and we found the identical condition described by Dr. Moore. We found the larval stage of this flatworm working in the ovaries, and it had attacked the ovaries to such an extent that it was very evident indeed that the fish would not spawn that year also. Further, the fish examined had been held in this pond for a year and a half and had made no growth, despite the fact that there was a liberal amount of food in the pond. This led us to a further examination of both the largemouth and the bluegill. We found the parasite in those also, but not to the extent that it was in the smallmouth. The worm was sent through the Washington office by Dr. Davis to some biologist who made a specialty of parasitic worms and he reported back that it was prevalent throughout the entire St. Lawrence drainage and that it no doubt had been introduced into the Neosho station by smallmouth bass which had been

shipped to us from the Put-in-Bay, Ohio, Station. Well, we were up against it. We had it there; we did not know the life history. So what we proceeded to do was to eliminate all smallmouth immediately, and later, as fast as we could we eliminated both all our largemouth brood stock and all our bluegills, together with the rock bass. We laid the ponds bare in winter time and then built up a completely new set of brood stock. This jumped our production better than one hundred per cent, and this last year we have brought about an additional increase by substituting some of our native fish in that section for brood stock which we received from other sections. I believe it is a mistake in a great many cases to go a long distance for brood stock. I believe that the fish in that section of the country, if you can procure them, become acclimated—or not necessarily acclimated, because they are native there, which the fish from other sections are not—and that it will be some time before your stock secured from other sections will equal in productivity those secured locally. It is a question that must be given serious consideration by the bass hatcheries in the country. We know what it did in Neosho, and the only solution we could see was a complete turnover of brood stock, laying the ponds bare with a possibility of breaking the life cycle of the parasites. I would like to hear the views of others on that point.

MR. CULLER: Years ago at Wytheville we had exactly the same experience that Mr. Foster has had at Neosho.

J. M. MURPHREE (Kansas): I am not prepared, Mr. President, to give a talk on bass; I am a new member of the society and this is the first time I have attended one of its meetings. I may say, however, that we raise smallmouth bass in two ponds. We stock the ponds by pairing off the fish, one female and one male, and using forty bass to the three-quarter acre pond, with reasonably good success. Our bass are not infected with disease, as far as I know. We stock one pond with forty adult smallmouth bass and we do not move out any of the adults from that pond until October; we let them remain there with the baby bass until that time. Then in October we drain the pond and take the baby bass and the adults out of the pond together. Instead of taking the adult bass from our ponds we try to stock the ponds with moss and shrimp—*Milina nitida*—and try to raise natural foods in the ponds. The shrimp are abundant in every pond; they find their natural food in the moss and thus they thrive and provide a good food for the young bass. We also have an abundance of crawfish. The pond below the one that is stocked with smallmouth bass, we stock with largemouth bass. I find that in that case we have more smallmouth bass drift into the pond with the largemouth than are raised in the smallmouth pond itself. Last year in pond No. 89 we took out 11,000 drift smallmouth bass and about 1,500 largemouth bass. This pond had originally been stocked with fourteen adult largemouth black bass. Then, we had 11,500 crappie in

that largemouth pond, from two to three inches in length, that drifted through the series of ponds to get to pond No. 89 on the lower side.

I have come to the conclusion that in planting food for your baby bass it is best to use crappie and bluegill, as these two species spawn after the bass do in the spring and the small bass are able to eat the young. The trouble I found with most of the other fish I planted in the ponds for the bass to eat was that the other fish hatched off first; they usually outgrow the small bass, so that they are of no benefit to the baby bass from the point of view of food. It is a good idea to plant about four pair of crappie to each bass pond for a food supply for the young bass. The crappie lays from forty to sixty thousand eggs each year and the eggs hatch out a little later than those of the bass do, so that the bass has a chance to eat most of the crappie. All the crappie, however, are not eaten in the pond, and we get as high as 1,500 two or three-inch crappie out of a bass pond.

I notice that most of bass culturists advocate the taking of adult bass out of the ponds, or they take the small bass out and retain them in small ponds and try to feed them. Whether that is a success or not I do not know. My opinion is that if you take what fry you get out of the pond after they are an inch to an inch and a quarter long and distribute them over the state while the water is cool in the spring of the year and then leave the rest in with the parent bass until October first, you will have more bass from the one pond than you will by taking them out and feeding them in small ponds.

I also use a net to catch the bass with. Our ponds are literally filled with moss, and I find it very difficult to seine the bass out of the ponds where the moss is so thick. We have a lot of water lilies in the ponds with the moss and it makes it almost impossible to use a seine. At the stage where the bass are just old enough to rise up from the nest it is an easy matter to catch them with a dip net. They are in about the second week stage at that time, but at that stage we do not care anything about it. After the bass attain a size, however, of an inch and a half in length, in order to catch them I take an 8-mesh screen wire, shape it in about a five-foot circle, bring the ends together to within an inch of the opening, and then put wings back about eight feet long. By using a trap like that I have got as high as two gallon-and-a-half water buckets full at one setting. It would take four or five men running over the ponds for a couple of days to catch the bass out of this moss with nets and seines. Of course in the same pond you might have two traps and only one would be successful in catching the fish. It depends on the direction that they are travelling around the pond as to where you set the throat of the trap. You can set two traps in the pond and turn the throat of one one way and of the other the other, so that whichever way the fish go they will get into one of the traps. you have to use your judgment in setting the trap. We use these traps

principally on the largemouth bass; the smallmouth do not circulate as well as the largemouth do. You probably will not have as much success with a trap of that kind in the case of the smallmouth as you will with the largemouth.

We have thirty-three ponds stocked with largemouth black bass. We have forty-six adult smallmouth bass in the hatchery and 840 largemouth adults. We stock with largemouth bass about 26 to the acre of water.

COLONEL WOODS: I would like to ask Mr. Murphree a question with reference to what he said about separating the adults from the small fish. Would he attribute the safety of the bass when not separated from the adult fish to the volume of vegetable matter in his ponds? Is that the principal reason why the baby bass are not eaten by the adult fish?

MR. MURPHREE: Yes. In the protection that the moss furnishes the small bass. Where there is no moss the small bass have a better chance to eat one another. I find that most of the loss among the bass is not from the adults, it is from the little bass eating one another. At our place I figure that a three-year-old bass ordinarily will spawn five to ten days ahead of the two-year-old bass; the older bass is the first one that spawns in our waters. So that if the older bass in the pond spawn first, those baby bass will be able to eat all the other young bass that hatch in that pond, if not taken out. The ones that are hatched off a week earlier than the other bass are generally able to eat all the rest that are hatched off from then on in the pond—that is, in a naked pond where there is no moss along the edges of the water for protection.

COLONEL WOODS: What would be the maximum depth of the pond?

MR. MURPHREE: Five feet.

COLONEL WOODS: Could you take the adults out if you wanted to, in that fairly congested water? Could you sequester them?

MR. MURPHREE: Well, not easily.

MR. ADAMS: I would like to ask Mr. Murphree if he constructs a nest in these ponds for his bass each year?

MR. MURPHREE: No.

MR. ADAMS: Do you build a nest in these ponds to maintain your adult stock in the ponds the whole year round? When the breeding season starts do you construct a nest or series of nests in the pond for your fish to use—a nest for them to deposit their eggs on?

MR. MURPHREE: No, we do not build artificial nests every year for the largemouth, but we do for the smallmouth.

MR. ADAMS: I am talking about the smallmouth. You tear the moss apart in places and build a nest for your smallmouth bass?

MR. MURPHREE: There is not as much moss in the smallmouth ponds as there is in the largemouth ponds.

MR. ADAMS: Are your smallmouth ponds literally covered all over by moss?

MR. MURPHREE: No.

MR. ADAMS: What portion of a half-acre pond devoted to smallmouth bass would be covered by moss?

MR. MURPHREE: About one-fifth.

MR. ADAMS: You build the usual type of nest each year by depositing so much gravel in a place and putting a wooden box around it? Is that the usual method?

MR. MURPHREE: Yes.

MR. ADAMS: Have you ever tried to construct an artificial nest of concrete and big gravel so that you would have the nests there year after year?

MR. MURPHREE: No.

MR. ADAMS: Each year you have to go back and put on new gravel and build the nests up to some extent?

MR. MURPHREE: I let the fish do that.

MR. ADAMS: How often do you try to build up or touch up these nests?

MR. MURPHREE: I just build them in the pond and they stay there permanently.

MR. ADAMS: What I am driving at is this: suppose you take a bass pond that you have never raised smallmouth bass in before. Now you go in there the first year and you build a sufficient number of nests to take care of the number of pairs you will put in the pond?

MR. MURPHREE: Yes sir.

MR. ADAMS: The next year do you do anything with those nests to freshen them up before putting your boxes around the nests?

MR. MURPHREE: No, we leave our boxes set around the nest.

MR. ADAMS: How many years can that condition go on before you have to do something to build them up?

MR. MURPHREE: As long as they do not filter over with mud.

MR. ADAMS: Then as long as they do not become affected by mud you just let them alone?

MR. MURPHREE: Yes.

MR. ADAMS: And rely on the bass to come round and clean them up?

MR. MURPHREE: Yes.

MR. ADAMS: Do you set around the nest the usual box to give the bass a certain amount of seclusion?

MR. MURPHREE: Yes,—two sides of a square.

MR. ADAMS: That is to say, a box with wooden sides out at right-angles and a cleat across the open end to hold the gravel in?

MR. MURPHREE: Yes.

MR. ADAMS: Has anyone in this room who is engaged in bass cultural work ever tried what we have attempted this year in Massachusetts, that is, to construct out of concrete a bed that will be there year after year so that we do not have to bother to cart in, as we have done in years gone by, so many loads of gravel and pile it on the old spots where the

nests have been the previous year. In one or more of our ponds we have constructed with concrete and surfaced over the top with rough gravel what we hope will be a permanent bed, so that each year instead of being bothered with this routine of building up the nests all we have to do is go and drop a wooden box there—probably take a broom and brush it off and put a little gravel on top of the permanent nest.

COLONEL WOODS: Is the gravel stationary in the nests?

MR. ADAMS: Yes, it is put in the concrete when the concrete is soft, so that it makes a permanent bed. We found that the gravel would sink down into the soft bottom of the pond and a considerable amount of work had to be done each spring before we filled the ponds with water—laying some plank in from the shore and perhaps going out with a wheelbarrow load of gravel and dumping it on that spot and dressing it up before we put the wooden frame around it. So we thought that if a permanent bed could be built, so that each year all you would have to do would be to brush off whatever silt had accumulated during the year and maybe throw on a little fresh gravel to cover the slime on the bottom of the bed, it would save a great deal of time and trouble. We tried that out this year and we found that it worked very satisfactorily.

MR. MURPHREE: How big gravel do you use when you put it down into the cement?

MR. ADAMS: Stuff which was from three-quarters of an inch to an inch in size.

MR. MURPHREE: When you use the larger gravel would not the eggs have a tendency to sink down between the crevices and lodge in such position that the male could not fertilize them?

MR. ADAMS: No, there are little open spaces where the concrete comes up, say about half way up the diameter of the gravel, and a little bit of fresh gravel—say enough to fill an ordinary galvanized iron bucket—may be scattered around the top to freshen up the nest.

MR. FOSTER: I had that under consideration a year or two ago and I will tell you why I did not do it. We had a lot of difficulty with fresh cement causing the disintegration of the gill of the fish. It turned the gill a cream color, then into brown, and then it sloughed off. We traced that back directly to the cement, because we cured fish that had been badly affected by transferring them to other waters. In one small pond we put in a section of cement six feet long, and it caused this gill trouble. What we should have done with it was to leach it out for a year or so before using it on the nest. I think the nest is a splendid idea, but I want to tell the people especially in the middle west to look out for the cement they get there, because it is liable to cause trouble.

MR. CULLER: We used a concrete nest at Wytheville, Virginia, back in 1905-06. The nests were made up during the winter months and then placed in the ponds in the spring of the year with the adult fish, and we had fair success. We used small gravel, not over half an inch

in diameter, and then after the nest was placed in the pond we put possibly a quart, or a trifle more or less, of fresh gravel on it.

MR. MURPHREE: May I refer back to a question that was asked by Mr. Adams about cleaning out the nests in the smallmouth bass ponds? Our smallmouth bass ponds have natural sand and gravel shores. Where we set our nests it is small sand running up to pretty good sized gravel say an inch in diameter. As it is natural sandy and gravel ground, I do not have to clean off the nests every year—they stay clean.

MR. ADAMS: Ours are mud bottoms. That would make a lot of difference.

MR. TITCOMB: I would like to bring out one point in connection with Mr. Foster's remarks. I asked him a question privately just now as to how long the pond remained drawn while the cement was setting, and he tells me the pond was drawn and kept drawn about two or three weeks while the cement was setting, yet he got that effect on the fish. I hope Mr. Hayford will talk on this bass question, and I hope we will get a little clearer idea how Mr. Murphree catches the young bass by swinging his wire around and making a sort of pound net. Is there anyone here who can draw that on the blackboard?

(Mr. Murphree illustrated his trap by a blackboard sketch with explanatory comments. He said:)

MR. MURPHREE: The trap I use consists of $\frac{1}{8}$ -inch mesh galvanized wire screen three feet wide and eighteen feet long. It is circled around, making about a six foot diameter circle, with the ends slightly turned in toward the inside of the circle. Then I use a three by eight foot screen for wings, which are attached to the ends of the circle screen at the opening and extend outwards on each side in a sort of funnel shape, one wing going directly to the shore and connecting with it, thus cutting off any passage through at the shore edge.

We use two stakes at the ends of the circle screen. These stakes are shoved down into the mud and they keep the opening, which is about one inch, in a fixed position. We fasten the trap down by putting in a few stakes around the circle, which also serves to keep the screen upright.

MR. ADAMS: You find by this system that you can practically clean the small fish out of a pond any time?

MR. MURPHREE: Well, you cannot clean them all out, but you can clean them down to where they are not so numerous or thick.

MR. TITCOMB: How late in the season can you operate that? Can you operate it in September?

MR. MURPHREE: We operate this in June and July, then we pull it out. I might mention what caused me to do this. On twenty-four hours notice I was called on to load a fish car with 100,000 bass. I had three men to help me. It looked as if it would be quite a job to seine out that many from all that moss. We buy this screen in rolls, several rolls at a time. I had one full roll of it on hand when I thought of using it

for that purpose. I made three of these traps and caught enough bass to load the car—set the traps out that evening and took the bass out next morning.

MR. ADAMS: How big was the pond you took the 100,000 bass out of?

MR. MURPHREE: I set the traps in three different ponds three-quarters of an acre in size. When you do not catch what you want in one pond you just move the trap over to another.

MR. ADAMS: After you discontinue using this trap how do you get the remaining fingerlings out of your pond that fall?

MR. MURPHREE: We leave them in there until October, then we drain the pond and take everything out.

MR. ADAMS: The bass will flow down into the centre of the pond wherever your greatest depth is.

MR. MURPHREE: Yes. Sometimes we have men go around the edges and work the moss to keep them going down, and they come down against the net before the water gets away. Two men stand there with dip nets and dip them out of the water as they come out against the net. The adults are put in a container five feet in diameter and three feet high and the small ones in another container of the same size.

MR. ADAMS: You never resort to the seine method to collect your fish when you come to take them out in the fall?

MR. MURPHREE: No, we do not use the seine method then; we drain our ponds.

MR. ADAMS: Do any of these fingerlings in October get caught in the moss, or do they follow the water as it drops down?

MR. MURPHREE: We have a man put in his time working that moss and picking up what fish are in it, and in walking around it has a tendency to keep the little ones running into deeper water. Down towards the last, when the water goes down, it sometimes takes three men to pick up around the edges.

MR. ADAMS: Even at that you can make better time than if you were trying to get them out by any small seine.

MR. MURPHREE: Yes.

MR. ADAMS: How long do you hold your fish for shipment?

MR. MURPHREE: We do not try to hold them over two weeks.

MR. ADAMS: What kind of container would you hold them in for two weeks?

MR. MURPHREE: In tanks seven feet wide by sixty feet long, four feet deep in the deepest place, running back to three feet. There is an eight inch wall separating the tanks of concrete. There are five of them built in a series and separated by walls.

MR. ADAMS: Do you attempt to feed your fish during that two week period?

MR. MURPHREE: No sir.

MR. ADAMS: In the case of a three-quarter acre pond, from the time you first start to draw the water out until you have it down to where you are taking out the last fish, over how many days do you carry on that operation?

MR. MURPHREE: It takes twelve hours to draw a three-quarter acre pond.

MR. ADAMS: Do you draw it right down?

MR. MURPHREE: Yes, do not waste any time. Of course in the bigger ponds it takes longer than one day to drain.

MR. HAYFORD: This subject has been pretty well covered, but there are three or four matters I might refer to that may be of interest. One point that has not been touched on in this discussion, so far as I know, is that of the wintering of the large fish. When I first started in I had a great deal of trouble in carrying my brooders through the winter. The first winter they became very emaciated and did not reproduce very well. I went to see Mr. Lydell and explained the condition of the ponds, and so on, and he made certain suggestions with regard to desirable methods of laying out the ponds.

(Mr. Hayford illustrated on the blackboard his method of pond construction, with a running explanation.)

Mr. Lydell said he found it necessary to have running water for the smallmouth breeders in the winter and for the largemouth the reverse was the desirable condition. Our aim, therefore, was to construct a pond that would meet these needs. We filled this pond up with golden shiners, etc., along the lines of his suggestion. The first winter we used this pond the bass came out fine; we put the largemouth in because they were the ones that I had been largely having trouble with. About fifteen or twenty smallmouth bass got into this pond in the winter. They did fine, and for two or three years we put the two varieties in the pond and found they would come up very well in the spring of the year. That seemed to solve our wintering problem.

Our grounds there are of a clay formation and when I first started, one of the difficulties I found with the bass in the spring of the year was the presence on the lower jaw of almost every bass of a raw spot anywhere from the size of a dime up to half a dollar. Some of them would be eaten all the way back, and when you got them up you had to be careful because the slightest wiggle would almost break that lower jaw open. The ponds in which this occurred were of about one acre with a depth of about five feet.

The next point to which I shall refer was well covered last year, so that I will just touch upon it—the abundance and production of food organisms. Getting the food organisms started in the spring appeared to be an innovation. We have about twelve ponds there now with an acreage, roughly speaking, of twenty-three or twenty-four acres. We found that here would be a pond perhaps two or three years old where

this year we would have good success with the fingerlings, and next year we would have just as many fry so far as we could see, but they did not grow well. So Dr. Embody spent some time on that problem. We started in drawing these ponds all down and putting in six or eight quarts of bone meal fertilizer and half an ash can full of horse manure, and we got the following insects—I will just read the notes as Dr. Embody put them down. Here is his description of pond 5:

"Plankton rich, consisting of the following as the more abundant: Chydorus, the most abundant; Cyclops; Scapholebris and Simocephalus, ranking second; Rotifera."

His note with regard to Pond 6 is, "only fair now." Pond 6 is right ahead of 5 and should have been better than 5. As to pond 7, "Plankton very rich, Simocephalus most abundant." Now 6 is between 5 and 7, running one after the other, and we could not understand why 5 and 7 should be good while 6 was poor, the water conditions being the same and all being fed from this big stock pond. So to help overcome that we started in to produce myriads of these insects in small concrete pools five by thirty. This year we ran thirty-six of these little ponds, and we found the production of the insects to be of great value, particularly in securing more uniform growth. I may say that I am speaking about the largemouth in this connection. We got 117,000 fingerlings out of these two ponds, Nos. 6 and 7. Last year we built a new pond, No. 10, and did not expect to get very good results there because we did not have the plant life in it, but No. 10 gets the wash from the stables where we keep the horses, and when Dr. Embody made the examination we found to our surprise that No. 10 was the richest pond on the place and that the bass in that pond did better than anywhere else. Here is the second year report on No. 10:

"Largemouth bass fingerlings, the largest on the place. Plankton exceedingly rich, exceeding that in any other ponds. Simocephalus, Chydorus, Cyclops, commonest forms."

Right back of No. 10 is No. 9, which is an older pond by one year, and his report is, "Plankton fairly rich."

I was interested in what the gentleman from Kansas had to say on the question of fry. We sometimes catch the largemouth bass fry in rivers. We find them running five or six thousand to a school and we can get an entire school with a twenty-foot net. We bring them into the little tanks with practically no loss. For two years we have put fry directly from the rivers into ponds Nos. 8 and 10. Last year from pond No. 8, which contains about an acre, we shipped out 24,000 No. 1's, about 11,000 three to four inch largemouth bass on the first of September. We have had a very interesting experience in connection with pond No. 10. This report says that pond No. 10 was exceedingly rich in aquatic life. This year we put out what we needed from the river into this pond. These bass started out and made a very uniform growth and

when I left home they were averaging between three and four inches. We had no difficulty in getting them to take artificial food almost from the start. The boy who buys the feed now has been four years at it, and he is quite pleased, because he always disliked raising maggots. He took great pains to make this experiment a success. We started these bass out on ground hearts and sheep's plucks, run through the second plate, which is one-eighth of an inch in size, and for the last four weeks those largemouth bass, when he would throw a spoonful out into the pond, would break all over the pond just as trout do. We had never been able until this year to do what they did at the state hatchery down in Louisville, Kentucky, but this year when the fish got a couple of inches long we could work them up to it without difficulty, using all the stuff I have previously referred to.

We also experienced some of the difficulty that Dr. Moore has referred to in her paper. For some two or three years I would get a good hatch and then I wouldn't get them, and I found on opening up the fish that died that there were adhesions, caused by the flatworm, I suppose. In 1911 they had a great deal of trouble with that in Culver's Lake, which is a body of water about two miles long; and the report came back from the Bureau of Fisheries that the trouble was caused by the flatworm.

Then there is the question of the complete drainage of ponds to exterminate noxious aquatic insects and remove any young fish that have previously escaped the nets. Of course we do not have the muddy condition that a great many have to contend with. We can drain all these ponds out and let them lay out all we want to. Our bottoms are solid so that we can go in there with horses and drive around practically all the ponds, except in two or three places. I might mention that I have been removing all the weeds, but last fall instead of removing them they were piled up in little cocks around the pond, in accordance with a suggestion made by Dr. Embury, and allowed to remain that way all winter. He claimed that that would give a chance to protect all the winter eggs; I think that Dr. Moore can explain that better than I can. His idea was that by piling these weeds up in the ponds we would get the rich growth of aquatic insects that we wanted this year, and we believe that it is a better plan than cleaning out the weeds.

Another thing we do is keep what might be called paths through the ponds so that the bass can run around. We keep the shores clean in spots so that when a big one comes along the little fellow has a chance to get out of his way if he wants to.

Of course I do not have to get out 100,000 bass on short notice. We work ours on trucks, taking out thirty cans at a time. Often the boys will get as many as ten or fifteen thousand fish out of one pond in a couple of hours. Of course, as Mr. Murphree says, if we see they are not going to come in pond 8 we can go to another pond and get them with these little wire cages. That is the way we work it out there. Of

course if you happened to run into very rainy weather and you wanted to ship the next day it might not be so easy. Another thing: in feeding these insects it is a natural tendency for them to keep coming back. Of course the ponds are very rich anyway, but if we want to work 6 we put a little heavier flow of water and that has a tendency to throw the insects from 6 up to the flume.

MR. MURPHREE: When you use seines in catching fish around the edge, what size are your fish at that time?

MR. HAYFORD: We seine them from the time they get off the nest up to the time they are an inch and a quarter in length.

MR. MURPHREE: When I came to the Kansas hatchery I decided that we would put out a lot of fry. Well, we got everything ready and we found that we got about as many Potamogeton as we did bass. We just dumped them over into a tub, and I noticed that the little bass began to get crazy right away. That was one reason why I had to resort to something else besides seining for the baby bass. Of course after the bass got up to an inch or an inch and a quarter in length the Potamogeton have practically all disappeared, and seining would be quite practicable in our ponds.

MR. HAYFORD: I think probably each one has to work out his own salvation and take care of his own difficulties. We do have Potamogeton but they do not bother us.

MR. SURBER: Do I understand that your ponds are in series, each one overflowing into the one below?

MR. HAYFORD: Yes.

MR. SURBER: For instance 5 into 6 and 6 into 7, and so on?

MR. HAYFORD: Yes.

MR. SURBER: Is No. 10 the last pond in your series?

MR. HAYFORD: No, we simply designate the pond by numbers in that way so that you can tell the men readily where to go to work on the various ponds.

MR. SURBER: We found this summer at the Detroit hatchery that there is a decided tendency for all our fry to follow the current down to the lower ponds. The Entomostraca, Copepods and other minute crustaceae would have a tendency to do the same thing; might that not account for a preponderance of food in the ponds below over that in the ponds above? Why should not the Entomostraca do the same as the fry, that is, follow the current down to the lower ponds?

MR. HAYFORD: That cannot occur with us because of the flume system we have. (Mr. Hayford makes further explanation by means of illustrations on the blackboard.) We have a screen through which even our bluegills do not go to any extent, and they are much smaller than the bass. You could almost stop the daphnia with the screens if you wanted to. We watch pretty closely the matter of the daphnia drifting. This year we had a lot of daphnia get down here in No. 8.

We could hold that all right by easing back on our water (further descriptions on board.)

MR. SURBER: At Detroit we have screens with one-eighth inch mesh, large enough to permit fry and even insect larvae to pass through. They evidently all went down to the lower levels, as the fish did.

MR. HAYFORD: We never use a finer mesh than fourteen to the inch.

MR. FOSTER: I would like to ask Mr. Hayford, as to this bass brood stock in the pond that he wintered them through, whether he fed them on artificial food during the winter or just depended on the natural food he put in the pond late in the fall?

MR. HAYFORD: We put in anywhere from 15,000 to 50,000 golden shiners from three to five inches long, so that they can help themselves whenever they want to.

MR. FOSTER: There are not many crawfish?

MR. HAYFORD: Not to amount to anything—could not get fifty in all the ponds. Sometimes we wish we did get them. Lydell gets them by the barrel full. We have put a ditch back of our four biggest ponds in the east section to keep the larvae out. These ponds contain about eight acres, and it is a question in my mind whether I would not be better off, so far as the largemouth are concerned, to take the fry right out, seine out everything we can and bring it over into these other lakes. There seems to be a natural tendency for the big bass to worry the little fellows. I would be tempted from the experience I have had with the wild bass breeders to let them all breed in these four ponds and hold my bluegills in the cooler water where I could keep the temperature down with spring water, and then draw these four lakes right off. Last year I got something like 100,000 bluegill fingerlings, an inch plus, in about an acre pond.

DR. MOORE: What is the source of supply of your golden shiners?

MR. HAYFORD: We have a great many of these in different places around there, and we can get five or six truck loads of them any time we want them. We also get a lot of them from the canal when it dries out in the winter.

DR. MOORE: You bring them in in the fall and stock up your ponds?

MR. HAYFORD: Yes, where we have the breeders.

DR. MOORE: Do you think they breed the following year too?

MR. HAYFORD: We do not give them a chance to breed; we take the breeders out and divide them around. For two years I took the golden shiners out and put them in the pond and let them breed, and it is very interesting to see how prolific they are. The goldfish grow much faster than the bass. I may add that the golden shiners cannot be brought in until the water gets cold, along in September.

DR. MOORE: They are tender to transfer?

MR. HAYFORD: Yes.

MR. LAIRD: I would like to ask Mr. Hayford how soon he puts the water in after he puts the fertilizer in the bottom of the pond?

MR. HAYFORD: As quick as we can get it in.

MR. LAIRD: How long after that do you have Daphnia, Cyclops and other Entomostraca?

MR. HAYFORD: The stuff is fed in from this lake into the little pools, and sometimes you get the growth in five days.

MR. LAIRD: You mean by that that the Daphnia and other things come in with the water and then—

MR. HAYFORD: No, it is small—they will take pail full after pail full out of the pond. There does not seem to be so much in it.

MR. LAIRD: The idea, too, in the use of the manure is the feeding of small stuff that comes in and which helps the growth?

MR. HAYFORD: Possibly some scientist can explain that. There are certain things from the manure that you need, and then there are other things from the bone meal. There are two or three different elements. Dr. Embody could explain all that if he were here.

MR. HESEN: I would like to ask Mr. Hayford what the temperature of the water is in the ponds in which he winters his bass?

MR. HAYFORD: On this big pond last winter we had about fourteen inches of ice, and the temperature would be down to probably 34 up along the surface. Down at the bottom, of course, it would not be so much. There are three or four little springs in the pond but there are not enough to influence the pond as a whole.

MR. HESEN: Do you put four to five inch golden shiners in the pond?

MR. HAYFORD: Four or five truck loads—forty or fifty thousand.

MR. HESEN: Of what size?

MR. HAYFORD: They would run in size anywhere from three inches up.

MR. HESEN: How many would be in the pond in the spring?

MR. HAYFORD: Some springs not more than perhaps five hundred; others there might be three or four thousand. We put them in along the middle of September to give the bass a chance to feed up heavily on them before the pond closes up. If you did not put them in until November or December the bass would not come on in very good condition in the spring.

MR. HESEN: They would probably devour all of these between October and November?

MR. HAYFORD: Yes, probably so. They are there and the bass can help themselves any time they want to.

MR. HESEN: I was wondering whether on account of the hibernating instincts of the fish it was necessary to put in that number of golden shiners for them.

MR. HAYFORD: Well, it doesn't make any difference. We put in what we get and find means of using them all up before the year is over.

MR. BENGARD: What is the lowest temperature in which bass eggs will hatch?

MR. HAYFORD: You have got me on that. I do not have very good luck when the temperature gets below fifty; in fact I lost practically everything.

MR. BENGARD: Will they hatch at fifty or not?

MR. HAYFORD: I have not gone into that temperature question; some of the Bureau men could give you better information on that than I can. I keep my bass temperature at 52, as near as I can, around the first of June and then put them in these ponds with a temperature of 65. If we get a cold snap, as we did this year, we are out of luck.

MR. BENGARD: I had some goldfish down in New Mexico; I put them in water of 54 degrees and they laid apparently hundreds of thousands of eggs but not a single one of them hatched. I was wondering if bass and goldfish required about the same temperature. In my case the goldfish would not hatch in water of 54 degrees.

MR. HAYFORD: I think it is generally agreed by those who have written on bass that when you get below 55 you are getting into difficulties.

MR. SURBER: My experience has been 56, based on a number of experiments we made at the White Sulphur Springs hatchery. A temperature of 50 was almost invariably fatal to the eggs as well as to the newly-hatched fry. Fifty-six was the temperature at which they began to spawn and 60 was about the average temperature when they were spawning in increased numbers.

MR. HAYFORD: It works out practically the same with me.

MR. MURPHREE: With regard to what Mr. Hayford has said about holding the ponds dry in the spring—

MR. HAYFORD: Not in the spring—in the late fall before the winter sets in. We start in with No. 12 and work backwards. When I get home we will start drawing those ponds and as fast as we get back we leave them dry. We let the ponds lay dry as soon as we take the bass out and until we begin to get the first heavy winter frosts. The frost sometimes penetrates two feet in exposed places. When that time comes we pull the water right out again.

MR. MURPHREE: Don't you find that a pond filled in the spring, held dry a while and refilled with fresh water, accumulates more *Daphnia* and little water insects than the one that stays filled until you get ready to start?

MR. HAYFORD: A number of times we have had to run our ponds right up to the trout season, simply because we carry trout seven, eight and ten inches during the winter. If we do that, sometimes we cannot clear those ponds until the first of June. If we do not get a chance to dry those ponds out for three weeks the aquatic production is very poor.

MR. MURPHREE: In our little ponds where we have the channel cat I turn the water in about the first of June and I find that in about two weeks the water is literally filled with *Daphnia*, whereas they do not seem to be so plentiful in the water when it has been in the pond all winter.

MR. FOSTER: I think for Mr. Murphree's benefit we ought to state that it has been proved that freezing benefits *Daphnia* eggs; that they hatch out much more prolifically if frozen than otherwise.

MR. MURPHREE: I did not understand the hatching of them to that effect.

MR. BURNHAM: The question of temperature suggests to me a point about which I would like a little information, if it is in order. I would like to know if the scientists and experts who have given this bass question study have ever considered the advisability of trying to increase the supply in wild waters; whether their observation and intensive study have ever led them in that direction. As I understand the situation, the fact that we have not more bass than we have in the so-called wild waters is due very largely to the bad breeding seasons when the temperature of the water changes and destroys the eggs and young fish. Has the idea ever been followed of benefiting the bass under the natural conditions so that there might be a larger result under those natural conditions? We all know that the bass is a fish which cannot be produced in as large numbers as other fish by artificial propagation, so that if something could be done to help the bass under natural conditions the results might be of value. Last winter at Grand Rapids I talked with Dwight Lydell and asked him this question. He told me he had some ideas on the subject but that he had not got them sufficiently formulated at that time to discuss the matter. As a neophyte in science I cannot help thinking that something of great value could be done along this line, something which would be welcomed by all those who love the sport of bass fishing. For example, could some method be devised of keeping the bass from coming too early on the shores of those natural waters where they spawn, so that there would be a fair chance of their spawning naturally without being adversely affected by cold spells? Possibly the use of sulphate of copper might be considered, to make the bass shores so undesirable that the fish would be kept off in deep water until the last minute. That is just an example of something that might be done to increase the number of seasons that bass can spawn under natural conditions.

MR. SURBER: Mr. Hesen brought out a point just now that I would like to make an observation on, namely, the hibernation of black bass. From my observation during the past two winters in Minnesota I am of the belief that we shall have to modify all our views in regard to the so-called hibernation of bass. In other words, I do not believe the bass hibernate. In White Bear Lake and other lakes within a radius of fifty

miles of Minneapolis and St. Paul largemouth bass were caught in great numbers throughout the winter under three feet of ice. They were caught with hook and line while fishing for other fish. During the month of January I know that five or six hundred bass—from the records kept and the various reports received at the office—were taken in White Bear Lake, and no doubt many other hundreds were taken that we have no record of. The winter before it was practically the same: they caught bass five or six pounds in weight. But usually they were large bass; I do not think that any were reported under legal size. It was always my understanding previous to that that largemouth bass hibernated the same as smallmouth.

MR. TITCOMB: I will answer Mr. Surber's question first. In my long experience I have known of only one smallmouth bass to be taken through the ice, and that was early in the spring. The sun was quite bright and the ice was melting. We generally recognize largemouth as capable of being easily taken through the ice, and for that reason we have recently had legislation making a close season throughout the winter. I do not think the smallmouth ordinarily needs protection in that respect.

Mr. Burnham brought up a very important question, one that we know very little about. We recognize that in almost any water inhabited by smallmouth bass we get less adults to the cubic content of the lake or pond than we do of almost any other species of warm water fishes. Many of us have studied the question in a rather desultory way. We have tried to encourage vegetation in some of these waters feeling that the difficulty was lack of food. Now it has been my experience that in almost any natural body of water inhabited by smallmouth bass we get sufficient reproduction to stock the lake, but the young do not come to maturity. We have had breeding seasons with almost all species. We have it with the pike perch—with a sudden drop in temperature; also with the yellow perch; and of course you have had breeding seasons with smallmouth bass. We made quite an intensive study on Lake George, to which Dr. Moore has referred. The sportsmen wanted more bass. They could catch almost any quantity of smallmouth bass up to six or eight inches in length. The fish seemed to be abundant up to that size but were comparatively few of the more mature type. It is a very serious question, but I do not think it is a question of reproduction; I think it is a matter of getting these baby bass up to maturity after they have been hatched. How do you feel about that, Dr. Moore?

DR. EMMELINE MOORE: I think there is a great deal of truth in that. Mr. Burnham has made the scientist very embarrassed by showing up a colossal ignorance. We greatly deplore the ignorance of this question of rearing bass in nature, but the fact exists. And this question of rearing the bass that do hatch is a very important one. Dr. Stanton, to whom I referred in my paper, mentioned that in all his experience up on Lake George, and that has been for several years, he has never

seen so many young bass—that is, this year's hatch,—around the shores of the lake, and last year in all his experience he has never seen so many of the small sizes—under-sized bass. But they did not get the large sizes, so there is some link that we do not understand yet. I deplore the fact that we have not given it enough attention. It really needs very careful and close study.

MR. TITCOMB: It appears to me that this question Mr. Burnham has brought up is quite as important as the artificial propagation of bass. Now some of the men who propagate the bass do not like to yield to my ideas on this subject, but I maintain that in any lake which is a natural bass lake there is sufficient natural reproduction to stock the lake. What we want to know is how to bring these young to maturity. Buller says the same thing; he is propagating bass because he is yielding to the demands of anglers there, but he still asserts that natural reproduction is sufficient. Of course we have the question of regulation to consider; it is very hard to keep people from taking the bass off the nests, with resulting destruction of the potential progeny of that nest. A four pound bass may yield 25,000 young, and when the nest is taken care of until these young are scattered, if there is no temperature change, then the problem arises as to how to bring them on. I wish we could have someone take that big question up. My idea would be to pick out the most productive bass lake we know of, study the conditions there, and then work back on some of the other lakes. That is my suggestion as to how to tackle this problem with various species of warm water fishes: why do we get so much more production in one lake than in another? The bass confines itself to limited areas in many lakes, and I feel that the areas which are congenial to the bass should be a basis for the maximum production of any lake. You may have a body of water which has a very small amount of the cover which the small-mouth bass like—rocky shores around islands, and so on, of which Lake George has a good deal. There is also a great deal of Lake George in which you never find a bass. You cannot take the area of a lake as the basis for the production of any particular species of fish, and with the bass it seems to me that the limitations are more marked than with most other species. The limitations are absolutely defined by the areas which are the recognized habitat of the fish. Our problem is to make that habitat as prolific in food as possible and as congenial as possible. The question is how best to do it.

MR. FOSTER: So far the discussion of smallmouth bass reproduction has been confined to lakes. Now Mr. Woods over there has some fine Ozark streams where the smallmouth bass have been native for so many years, and unfortunately I am afraid we cannot say the reproduction there is satisfactory. Some of the conditions there are not as favorable as they may be found in lakes elsewhere. Heavy rainfalls occur along in the spring months; the water rises sometimes six, eight or ten

feet, literally destroying the nests. A great deal of sediment is brought down, and even in some of the back waters which are more or less protected from the flood element the turbidity of the water causes smothering of the nests. Then, we have constant temperature changes which I believe are even worse than those in the north, occurring, as they do, every year along in April or May. Sometimes there are drops of from 40 to 50 degrees in less than twenty-four hours, and of course that is disastrous. Then again, where we have a run-off and the high and low water conditions with the turbidity, you cannot expect the amount of food for the young bass as you can under more level conditions in your lake. So that I doubt very much whether in the spring fed streams of the Ozarks, where we have now very good smallmouth fishing, we can do anything to control the condition that would lead them to reproduce to a greater extent naturally, and I believe we shall have to produce the fish in the hatcheries. If you start to control them in the stream to any considerable extent you are simply getting into hatchery methods and the best thing is to start in with the hatchery.

With regard to the bringing on of the small fish, I refer back to Dr. Moore's paper in which reference was made to the number of refuges for fish that had been sectioned off in lakes and streams. If it can be determined what sections of the streams and lakes are affording the best spawning conditions and developing the most food, and if those can be put into preserves and not fished, I believe that would help in the solution.

MR. TITCOMB: Are the bass indigenous to those Ozark streams?

MR. FOSTER: The smallmouth bass is indigenous to them.

MR. TITCOMB: You have a condition there where artificial propagation would be necessary. But the point I want to bring out is that in most of these waters we are discussing—most of the New England waters, most of the New York waters, in which Mr. Burnham is interested—the bass is not indigenous. There were no bass in Connecticut or Vermont until they were introduced. Those waters are not original bass waters; they were trout waters.

MR. FOSTER: I won't say positively, but so far as I know there have always been smallmouth bass in Missouri streams.

MR. TITCOMB: Is the bass indigenous to Ozark waters?

COLONEL WOODS: Absolutely, they were always there.

MR. TITCOMB: Have there been physical changes such as forest devastation which would cause a more torrential flow of water?

MR. FOSTER: Yes, to some extent.

MR. TITCOMB: Then you are up against the same physical condition that we have to meet in this trout proposition. We are doing a great deal of artificial propagation to overcome changes in physical conditions, which would not be necessary in the time of primeval forest.

MR. ADAMS: We have this same condition all over the country, and

I think it is going to prevail more and more, namely, the tendency to hook on to most of our ponds and rivers an exhaust to some water power system. Now it is true all through New England that the bass will make their nests in the spring during the latter part of May in a given depth of water. But by the time the bass have hatched, even though it is a very short period, because of the opening up of the gates in order that a certain amount of water may be taken out, the depth in which those beds were originally placed may be considerably changed. From that time on, clear through even into the fall, there are constant biological changes in those pools because of the water supply being drawn down more and more. The shores dry up, the vegetation disappears, and the fish are compelled to adjust themselves to a changing condition of water. Of course I do not know, but it stands to reason that if the biological environment is changing so rapidly in a great many of our ponds and rivers it may have a great deal to do with the case.

MR. TITCOMB: I think we are face to face with a very difficult problem on those lakes and ponds where the water is drawn out in the spring of the year. I find that in many instances the bass do reproduce in those waters and are very frequently drawn out with the drawing of the water. I have observed that where they are drawing for power the young bass seem to tend to go to the outlet, and when the water is drawn of course they go with it. In fact, we have rescued a lot of small fingerling bass in pools below some of these power ponds after they had been drawn out and had collected in the pools below, although a great many more of them were lost.

COLONEL WOODS: I am firmly convinced that if we do not augment our facilities by the acquirement of suitable ponds and wild waters for the propagation of bass we are going to be in a terrible dilemma. I heartily approve the practice of the hatchery. It came about, as would apply in our particular country, because our fish would run to the head waters to breed, in order to get away from the floods and freshets that occur in the spring, and unless they got absolutely into the top waters the floods would destroy mostly all their nests. Now, I am rather an observer than thinker, but it appears that when the fish culturists discovered that these hazards existed, on came the fish hatchery. It is as near nature as you can provide. But we had these things before we had fish hatcheries. It is true that the demand for them is growing and will constantly grow, but it will be necessary to augment the hatchery with these wild waters. And I want to tell you that wild waters are distressingly scarce. The dredge and the ditch are playing havoc with conservation so far as fish are concerned, and we must insist that the proper authorities acquire these things for the public. When that is done, a valuable step will be taken in the matter of fish culture.

MR. TITCOMB: Is it not a fact that besides the evils of the changes in physical conditions in the Ozark region there is a constantly increas-

ing number of anglers whose activities have been made possible by the use of the automobile?

COLONEL WOODS: That is entirely the trouble. That is why I say we must try in some way to increase our productivity.

MR. TITCOMB: Are these streams entirely closed to fishing during the breeding season?

MR. FOSTER: I regret to say that the laws in Missouri in regard to bass allow them to be taken at any time of the year, with the exception that artificial bait must not be used between the first of April and the tenth of June.

MR. TITCOMB: Then I would not do any propagating until those waters are closed against all fishing during the bass spawning season.

MR. FOSTER: I know that strenuous efforts in that direction were made at the last session of the legislature.

MR. LECOMPTE: I have listened with a great deal of interest to this bass discussion, which has proceeded from practically all angles. Mr. Burnham has touched a point which is a very essential one. I do not know how the difficulty can be overcome, even by the scientists. Conditions in the state of Maryland in the smallmouth bass territory are these: the streams that furnish smallmouth bass rise in the Allegheny Mountains, a great many of them in the upper part of Pennsylvania. The consequence is that during the spring freshets, which of course occur during the spawning season, these streams rise from a twelve-inch bed to probably ten-foot, depending on the snows in the mountains and how many larger freshets come down. We all know that must destroy the spawning beds, and it is a pretty hard proposition to overcome the problem of natural reproduction in those streams. Another great drawback to our smallmouth bass section is this, I am sorry we have not any legislation at present to stop it: the automobile and the good roads of Maryland have brought into our state a great number of non-residents. From four to eight fisherman will come in a car with their camping outfit and plunder the fisheries, taking all there is. They will even go so far as to bring creamery butter tubs, salt their fish down and take home all they can get, without paying a cent of revenue to the state. As we have no non-resident fishing license it is impossible for us to stop this practice. During the open season they have as much right to take fish in our waters, under the law of Maryland, as our own citizens have.

The largemouth conditions in our state are quite different. I think I can say without fear of contradiction that we have one of the best largemouth bass states in the union in proportion to size. We have twenty-three counties, nine on the eastern shore, and there is not a county on the eastern shore of the state that is not a natural spawning ground for the largemouth bass. The lakes or mill-ponds which you will find in each of the nine counties run from ten acres to one hundred acres in size. They are fed, as a rule, by sluggish springs at the heads

of them and in a great many instances from one to the other in a chain of three or four in the county. They have mud bottoms and are prolific in the natural cover and food for the largemouth bass, and these are the lakes we are using for the natural spawning territory instead of propagating them in the hatcheries artificially. This past season, in March, the commission took four hundred brood bass from the Transquaking and Little Blackwater and removed them to the holding ponds, twenty-three in number, at the state hatchery in western Maryland. These bass have done well, a great deal better, in fact, than any bass we have ever heretofore used as brood stock.

The question has been raised here about the adult fish eating the young fish. We have not had that trouble, but we have found that the young fish ate other young fish in the ponds with the brood fish. The brood stock did not bother their young, but the young did bother the young. Numerous sportsmen who are interested in planting the streams have told me they have watched them after putting them out and found the large ones chasing the small ones, even after liberation in the stream.

MR. HAYFORD: For three years I rowed around the shores of rivers and lakes in the spring when the eggs would be hatching out to see what I could pick up that would help me. One spring I found on three of those rivers, three miles long, that there were only twenty-two or twenty-three nests, due to a cold snap, that had hatched. From the observations I made I figured out that the most logical way to go about solving the problem was to protect them in their natural waters. I have observed that on the shores the smaller bass come into the shallow water, say eighteen inches to two feet deep, to spawn, whereas the larger bass, from two to three or four pounds, generally spawn in four or five feet. If you can protect your bigger bass in your natural waters I think you can go a long way toward solving the problem of holding your own in producing them. We do not have to worry so much about the largemouth, because he is easy to handle. The only thing that is against him is that in our state the season opens at the same time for both—June fifteen. Now I am trying to pick up what I can with regard to the wild conditions. Both last year and this, when the season opened, on a lake two miles long I caught three females—three last year and four this year—and none of the seven had spawned. The smallmouth had spawned. Most of our lakes are heavily infested with sunfish and pickerel and these devour all the young. I have seen two schools out in the wild waters come together, largemouth, with perhaps ten days' difference in their age. The large ones would be an inch and a quarter long and the small ones would be just coming in from shore; and there would be none left of the small ones—each big one would practically take a little one. I have seen all these things in wild waters under observation. I decided that if I ever got an opportunity, an experiment I would like to make would be to get a body of water where I could intro-

duce these bass and put a minnow into the lake for them to feed on. It is a very difficult thing to hold your own in your wild waters where you have so many different varieties of fish, sometimes as many as fifteen or sixteen. Our small pickerel down there when about two inches long find the smallmouth bass fry good picking as they come inshore. The small crappie are the same, and the small sunfish. You can go out today in the wild waters and spot a school of them any time. I believe, as a great many do, that wherever you can conserve the wild waters, it is the biggest thing of all, and I would only advocate work along the hatchery lines where the conditions demand it. In our state, for instance, we put in about one hundred small ponds large numbers of fingerlings to bring these ponds up. In the different altitudes lakes do not seem to be all hit by the same cold snap. In lakes in the higher altitudes which get caught by the cold snap I would use my stuff from the hatchery, and if the low altitudes got caught I would use my stuff from the hatchery there about every three or four years in order to overcome that disadvantage. About every three years we seem to get a poor year, and that is where your hatchery comes in—for use along these lines to try to maintain a proper balance.

MR. LECOMPTE: I would like to ask a question of the expert fish culturists here: Has anyone had any experience in trying to propagate smallmouth bass or brook or rainbow trout in the same lake—if it can be done?

MR. FOSTER: If you put rainbow in which are large enough, four or five inches, you will get good results. I have in mind one lake about seventy-four miles west of St. Louis where they are getting good bass and good trout out of the same lake. In the streams the smallmouth go down to warmer water than the trout, so that they will not overlap. About a month ago I fished in Eleven Point River, Missouri, and at one place we took both trout and smallmouth bass. The temperature of that lake stays under 78.

MR. TITCOMB: One great trouble with our bass lakes is that they are made over trout lakes, but with the devastation that took place the water got warm, the trout became depleted and they put in bass. The bass did well until they cleaned out all the trout, then the waters were too cold to produce bass in large quantities. Bass want comparatively warm water, and it would be a crime to put smallmouth bass into a lake where the temperature is 60 degrees. Put in all the trout the lake will stand and you will give your anglers sport they will never get if you put in bass.

MR. FOSTER: This was a bass lake before we put in trout, the one I was speaking about. I do not want to get myself in bad there.

MR. CULLER: I fully agree with Mr. Titcomb about the bass and trout proposition. In my opinion the only reason for putting small bass in a given lake is that the lake has food for them. If bass are put in trout

waters they clean out the trout, their proper food is not there, and consequently they are undersized.

MR. TITCOMB: I will give another illustration about the bass. There was a lake up in Vermont of twenty or thirty acres inhabited by pickerel, bullheads and perch. They put in smallmouth bass and the bass cleaned out every fish in the lake, and having done that they became a stunted race. You could cast a fly and get three rises of smallmouth bass every time, six or eight inches long. Very rarely was a bass caught there that would weigh over a pound. The place was teeming with them, but they were stunted. The water was natural trout water, spoiled by these coarse fish, and they spoiled it again by putting bass in it.

One point in connection with Mr. Foster's remark on trout and bass: the lake he refers to was first inhabited by bass but probably should have been stocked with trout instead of bass; it was a private pond. Now we sometimes give advice to a wealthy man who wants to spend his money and wants to play with water, and we say: "Yes, if you buy trout eight or ten or twelve inches long and put them in with bass you can have both fish—but they will be expensive fish."

In my own state almost all our lakes have been stocked with bass. A good many of them were originally trout lakes, but very few of them could be restored. They also have pickerel, perch and bullheads. They begin fishing these lakes the first of May; it is an open season for the perch, bullheads and pickerel. We have a close season on bass from the first of May until the first of July,—in fact from the first of November until the first of July, but you know what human nature is. We have one very nice bass lake near where Mr. Beeman has his hatchery. There a cottager can go to his cottage every week-end in May and go out and get perch and pickerel. He knows that some bass will grab his hook, and after he has had some fun playing with a three or four pound bass he cannot resist taking it in and cooking it. He says to himself, "Well, this is only one bass; we will take it and have it for dinner." We have decided that it is absolutely impossible—we could not do it if we had a hundred wardens on the lake—to protect these bass on the nests and allow a hundred boats to be fishing during that spawning season at the same time. We have decided therefore, to classify our lakes and we expect to ask the sportsmen to back up this proposition. We will call Lake Waramaug, where Mr. Beeman's hatchery is, a smallmouth bass proposition. We have another lake which is very prolific in pickerel, perch and bullhead, with an occasional smallmouth but not much of a habitat for smallmouth; we will put that in number two category, and we will provide that there shall be no fishing in lake number one or lakes of that classification from the first of May until the first of July which means no fishing except the ice fishing through the winter up to the first of January. For a period of about six weeks fishing with tip-ups is allowed, but in certain lakes we will not allow fish-

ing with tip-ups in the winter. Then, in lakes which we classify as number one special, which are looked upon as bass lakes, we propose to provide that there shall be no fishing during the entire spawning season of the bass, for any kind of fish. We believe in stocking these ponds heavily with perch and common fishes that are food for the bass, and then after the first of July let them go to it. The idea is to have a proper statutory limit so that they won't kill bass that are not mature.

METHODS USED IN RESTOCKING MINNESOTA LAKES AND STREAMS, WITH COMMENTS ON THE DANGER ATTENDING OVER-STOCKING CERTAIN WATERS.

BY THADDEUS SURBER,
St. Paul, Minn.

For some years the Minnesota Game and Fish Department has been conducting during the warmer months a survey of the stream systems of the state to determine the nature and approximate extent of the animal and plant life, the nature and extent of the pollution of the waters, and the extent and character of the water supply and its adaptability to fish life under existing conditions. During the course of these investigations some rather startling facts have developed, conditions so much at variance with hitherto accepted beliefs that some radical changes have become necessary in the distribution of the output of our hatcheries. While these surveys cover little more than one-tenth of the area of the state, excluding lake surveys, the surveys of several river systems have been thorough and sufficient information has been gained to justify a fixed policy of procedure for the future. For the purpose of elucidating my remarks it is necessary to mention the more important facts developed by these investigations and their bearing on our present policy of distribution.

By reason of the extensive farming and grazing interests in the formerly heavily wooded areas of southern Minnesota, many springs have either entirely dried up or the flow so decreased as to permit a rise of 20 to 30 degrees over the normal midsummer temperature. This condition has rendered many streams, once adapted to native brook trout, either unfit for this species or has reduced the area suitable for their existence 50 to 75 per cent. In many cases, in that section of the state, and even in parts of our vaunted North Shore section, entire streams have become uninhabitable for trout from this cause, the water sometimes reaching a midsummer temperature of 87 degrees Fahrenheit. However, some rivers have become unsuitable for trout from an entirely different cause, the cold swamp feeders on their headwaters having been destroyed by forest fires thereby permitting the rapid warming of the waters. In some of these streams we have been able to introduce brown trout with success, but in others the efforts are futile, and we are now stocking the larger streams with small-mouthed bass, using mostly adult fish for that purpose.

A decided decrease in the permanent flow of many streams has been brought about by drainage, by removal of the forests and subsequent cultivation of large areas around the headwaters, and by the destruction of immense areas of heavy forest and peat swamps by forest fires. The water-absorbing surface covering of the soil having been removed over extensive areas, the heavy rainfall is either carried off immediately through the numerous drainage ditches, which traverse the state in every direction, or immediately is absorbed in sandy regions and is of little permanent benefit. This condition has become so pronounced during the past five or six years, when according to meteorological records the annual precipitation has been below normal, that the quantity of water reaching our streams and lakes has been barely sufficient even in the belt of heaviest rainfall, up to the present year, to counteract the natural effects of evaporation during the summer months.

From the preceding remarks the natural inference is drawn that such conditions have had the natural effect of lowering our whole water table. The effect has been even more pronounced on our lakes than in our streams, by reason of their limited drainage basins. Many lakes have entirely disappeared while others have become so reduced in area and depth as to have become practically worthless.

The natural effect on normally shallow lakes, which comprise four-fifths of the lakes in the southern half of the state is extremely disastrous. The reduction of the permanent level four or five feet has the immediate effect of destroying the bulk of the aquatic plant life so necessary for the refuge and growth of the small animal life which constitutes the chief food of the young fishes, and of incalculable value as an oxygenator of the water. Also it destroys the natural spawning beds of the nest-building fishes. The reduced area tends to overcrowd the fish, a certain forerunner of disease and decimation. The natural result is that these waters are unable to sustain even 50 per cent of the fish-life which once they were capable of caring for.

With the exception of the Mississippi River stream pollution has not yet assumed serious proportions. However, a condition which has the same effect as pollution, exists in some of our trout streams, which pass through extensive pasture lands. The cattle and other farm stock frequent the water during a good portion of the day throughout the summer months. Their presence keeps the water in such continuous turmoil and renders it so turbid that trout can no longer exist therein although the waters may remain cold. In such waters we find that the natural food has ceased to exist or is seriously

diminished. The most serious source of pollution at the present time is creamery waste, but by the hearty co-operation of the State Board of Health we are now able to correct such conditions to a certain extent. All requests for fish for stocking lakes polluted by creamery waste are denied and this action is having a good effect.

All the previously enumerated causes affect the food supply of our young fishes, for without suitable food to sustain the young it is impossible to maintain the supply of adults. Of these causes the destruction of aquatic plant life, which has been brought about by the subsidence of the water table, is the most important. It has been the prevailing belief that carp were wholly responsible for the disappearance of aquatic plant life, but our investigations tend to disprove this contention. We recognize the economic status of the carp and at the present time discourage the planting of any native game fishes, particularly wall-eyed pike and bass, in waters badly infested with carp. While efforts are being made to curb the range of carp, we recognize the futility of trying to exterminate them, and many lakes now heavily stocked with this imported undesirable will eventually be abandoned solely to their cultivation unless some means of eradication, at present unknown, is devised.

The wanton destruction of suckers and other native, so-called "rough fishes", has sadly reduced one of the principal sources of food supply for our adult pike and bass. The old theory that suckers did enormous damage to pike spawn is as ridiculous as it is untrue, because the sucker, at the season of the year when pike spawning is at its height, consumes no food, while the ability of the black bass to guard their nests from encroachment is well enough established to render such a charge ridiculous. At the season of the year when trout eggs are developing on their spawning beds suckers are usually far removed, having retired to the deeper pools far below trout waters. On the other hand, an examination of the stomachs of the wall-eyed pike from the spawning beds of suckers show that the ova of these maligned fishes are consumed in great quantities by the pike.

Our investigations reveal that most of the minnows contrary to the feeding habits of our larger fishes, come from their winter quarters in the deeper waters ravenously hungry. This observation applies particularly to the carnivorous shiners—*Notropis blennioides*, *N. hudsonius*, *N. cornutus* and *N. atherinoides*, as well as representatives of the genus *Rhinichthys*. These shiners make their appearance in countless numbers

in the shallow waters of our lakes during the latter part of May, just about the time we plant our pike fry, and remain there until July well after their spawning period is over. An examination of the stomach contents of these minnows at the time of planting pike fry, will account for the disappearance of myriads of fry. Therefore, we have determined to make all future plants of pike fry in the deep water, where minnows are comparatively scarce at that period of the year. At this time also the natural food of the pike fry (*Entomostraca*) is most abundant in the deep water. This method of planting applies with equal force to the distribution of the fry of the Labrador whitefish in suitable inland lakes, but it is immaterial when plants are made in Lake Superior. The same rule applies to the planting of bass fry in lakes more or less destitute of aquatic plants, but I believe it is now generally conceded that bass fry, separated from the guardianship of the natural parent, are at the mercy of all predatory species. Therefore, our young bass are being held in hatchery ponds until they reach the fingerling stage before planting. Recent investigations have strengthened our belief that the most successful method of restocking with both species of bass is by the introduction of adult fishes.

While the practice of planting trout fry has not been entirely abandoned for economic reasons, it will be done as soon as sufficient ponds can be provided for rearing the fish to the fingerling stage. We have obtained abundant evidence of the destructiveness of spring and early summer freshets on recently planted fry and have established the fact that insufficient natural food exists in the streams in the early part of the season to properly sustain their existence. The only hatcheries from which trout fry were distributed this season are located at French River and Detroit, where the high temperature of the water obtained from the river and lake does not permit their retention to a later stage.

We are provided with a good fish car, properly equipped, though unfortunately, of wooden construction. For under the rules governing car movements its movement is restricted to certain local trains and thus proves a great hindrance to successful work, except for long hauls. During the rush of the pike season we rent four baggage cars to supplement the operation of the regular car. During the past two seasons a great deal of the distribution has been accomplished by truck and this method has proved far more economical than shipment by rail wherever our activities have been confined within the radius of fifty miles of the hatchery. The great advantage

of distribution by trucks operated by the hatchery men is the assurance that the fish arrive in the best possible condition, that they are planted properly by experts and that they reach the waters for which they are intended. Not only is the accuracy of our records greatly improved, for many applicants under the railroad system of distribution still persist in diverting fish to waters other than those for which the shipment is designated, but the method seems to meet with universal approval from every quarter. However, our most important plants are made without the formality of application, particularly in the most important lakes, since it is our policy to concentrate on those waters which are heavily fished. During the past season our trucks have given added proof of their efficiency, e. g., the French River Hatchery truck has spent 37 consecutive days along the north shore of Lake Superior in all sorts of weather, and has delivered to the trout streams of that region the greater part of the hatchery's output, without the loss of any fish.

During the last session the Legislature, which otherwise dealt liberally with our fish hatcheries, even providing for two new ones, turned a deaf ear to all our appeals for additional trucks. Eventually we hope to convince the Legislature that the truck system of distribution is superior to rail transportation for the delivery of fish to our public waters.

By reason of the shortage of natural food in the lakes heavily infested with carp, it has become necessary to abandon these waters to this species. The carp evidently consume the bulk of the insect larvae and Entomostraca which are so essential to a continuation of our native fish life. We have referred previously to the effects of semi-pollution (muddy water) on this class of animal life in our trout streams. This condition of affairs prevails to such an extent in many trout streams in the south-eastern counties that great care has to be exercised to prevent over-stocking. In certain streams of this region insect larvae of all kinds, particularly caddis larvae, have almost ceased to exist and shrimp are almost entirely wanting. Entomostraca, which are better able to withstand roily waters, are never found in any abundance in our trout streams. Food for adult trout in the form of minnows and crawfish are equally scarce. Under such conditions we consider that it is better to plant a reasonable number of trout according to the available food supply than to place therein an over-supply, and either force the fish to entirely abandon the stream or resort to cannibalism. For example it might be possible for two or three thousand trout by the aid of supple-

mental food in the way of terrestrial insects to thrive in some streams whereas the introduction of an additional thousand might result in entire failure.

Evidently many applicants labor under the delusion that the more trout they can dump into a stream the better the fishing. By so doing they actually defeat their very purpose. For several years past it has been a popular custom to apply simultaneously to the State and to the United States for duplicate plants. Nevertheless with this abundant supply the fishing has steadily grown worse, where by a more sane method the condition of those streams might have been vastly improved. Present-day conditions demand that we give such matters our closest attention since we have overturned the equilibrium of Nature and we must conform to Nature's law if we expect success.

MR. SURBER: I may add that I have with me a copy of a form letter giving instructions for the handling of live fish which for the past eighteen or twenty months we have sent to all applicants. We shall be glad to mail a copy to anyone who cares to have this letter.

MR. HAYFORD: Mr. Surber's interesting paper is now open for discussion.

Discussion

COLONEL WOODS: May I inquire what species of adult fish were planted by Mr. Surber and whether these fish were distributed for breeding purposes or to stimulate fishing?

MR. SURBER: We planted adult black bass for breeding purposes. Before this survey was made many thousand trout were planted in two northern river systems which flow into Lake Superior. No trout have ever been caught in either of these rivers except at their outlet into the Lake where the water is cold. On examination I found the midsummer temperature to be 87 degrees, which would readily account for the disappearance of the trout which either perished or passed down to Lake Superior over the falls. These magnificent streams had rapid, clear water and were supplied with enormous quantities of fish food, particularly for young fish. Having in mind that both branches of the Potomac River were stocked with almost immediate results with a few bass taken from the Ohio and having only adult bass available, we naturally resorted to adult fish in the attempt to stock these streams with the expectation of quicker results than by the planting of fingerlings.

COLONEL WOODS: Where do you collect the adult breeders? Is it rescue work?

MR. SURBER: No, we get them directly from the streams.

COLONEL WOODS: Do you plant any supply of fish by simply taking them from one water and putting them in another?

MR. SURBER: We do not take any large quantity. We planted only fifty or sixty pairs in those waters, but intend to plant more this fall. Most of these fish were used as brood stock at our hatcheries last year.

MR. CARPENTER: In moving these fish by truck, did you use ordinary milk cans or tanks with aerating apparatus?

MR. SURBER: Ordinary ten-gallon milk cans.

MR. TITCOMB: I think we all agree with most of the policies carried out in Minnesota. Probably each state has to adjust itself to local conditions, just as each hatchery has to study its local problems. I was rather surprised at the statement Mr. Surber made about suckers. I think the suckers have been much maligned and have been charged with causing more damage than they do. Possibly their usefulness is not fully appreciated since the young suckers make splendid food for small fish. My experience with suckers has indicated that under certain conditions they will clean up a trout bed. In trout streams where there is swift water few suckers are present, but there are places where you find them. When the trout spawn in areas inhabited by suckers, you will invariably find suckers on the spawning beds. I had the unusual experience of hatching a trout egg which was taken from the stomach of a sucker. The sucker which was evidently caught just after the egg was swallowed, was opened out of curiosity and several eggs were found. The fact that we succeeded in hatching this egg indicated that it had been fertilized under natural conditions.

MR. SURBER: I would like to explain that my statement applies solely to my own observations. I have no doubt that many of the gentlemen here would disagree with those findings. In our operations on the upper Mississippi we found an enormous run of suckers. The suckers were following the pike and spawned shortly after the pike had finished spawning. During a spell of warm weather early in May, we examined the stomachs of some five or six hundred of these suckers and I do not believe more than fifty had anything in their stomachs. These suckers were taken from the natural spawning beds of the pike with empty stomachs, although they had abundant opportunity to feed on the spawn. In fact, if hungry, I believe suckers will eat even their own eggs. I do not believe a statement of this kind can be applied to all waters because natural conditions may be different or a different species of sucker may be present. Apparently it holds true for the average stream in Minnesota. It is a very rare thing in our cold north shore streams to find any suckers.

DR. EMMELINE MOORE: I would like to ask Mr. Surber how long an interval elapsed between the capture and the examination of these fish? The eggs of any fish are readily digested and would not show unless the fish was examined very quickly after capture. There are two reasons

why one might not find eggs in the stomach. When fish are caught they naturally regurgitate what has been taken recently and, the digestive processes being rapid, they might completely digest any substance in the stomach, if examination did not take place quickly.

MR. SURBER: These fish were opened immediately after capture when they were still alive.

MR. COBB: At the same time that Mr. Surber examined these suckers in the Mississippi valley, an examination of the black sucker in Pike River flowing into Vermilion Lake showed them to be literally filled with wall-eyed pike eggs. In fact by grasping the sucker by the tail and giving a firm quick pull, you could get a cup full of eggs from its mouth. They followed the pike upstream from the lake each night and apparently cleaned up the spawning beds where the eggs were deposited in great numbers. Their migration for spawning took place a few days later after the pike had finished spawning.

MR. BENGARD: We have a trout lake in New Mexico which was stocked heavily with trout six years ago. At that time it contained a large number of suckers. The trout developed wonderfully, but during the last three years there has been absolutely no increase in numbers. The rainbow and black spotted native trout would go up the small streams to spawn. When the water was cool, about the first of June, there were no suckers in the creek, but a little later, about the fifteenth or twentieth of June, the suckers came up in great numbers. On opening suckers caught with the trout I have found as many as fifty trout eggs in their stomachs. On one occasion I watched a pair of trout spawn on a small gravel bar in the lake and around the pair right on the top of the bed I counted eighteen suckers. Invariably they would catch the eggs before they hit the bottom. We have declared war on the suckers in that lake and this spring fifty-one tons were caught in traps by a crew of four men in six weeks.

MR. TITCOMB: What was the average weight of the suckers?

MR. BENGARD: They were nearly all the same size, about a pound and a half. I have seen them so thick in the creek that you could not see the bottom. They do not spawn until they are two years old.

MR. TITCOMB: What did you do with them?

MR. BENGARD: Every man who came to the lake and produced a fishing license was given fifty pounds of suckers free of charge. To commercial fish dealers we charged two cents a pound provided a thousand pounds or more were purchased. We just managed to pay expenses.

COLONEL WOODS: What did they do with the suckers?

MR. BENGARD: They ate them. It is a good fish if you like it. We are planning now to build a tank around the big pond at the trout hatchery, haul the suckers over to the tank, and use them to feed our small trout. We find that the bones of the suckers stick through the gills and stomach of the little fish, so I am planning to use a pressure

cooker with twenty-five pounds pressure for two hours and a half and then put the food through a fine screen. We are paying an average of \$65 a month for beef liver and hearts for fish food at our large hatchery where we are raising practically every fish up to fingerling size. Our bill has been as high as \$80 a month and we are going to make good use of suckers next year.

MR. FOSTER: I have just returned from Arizona, and at the Roosevelt Dam and at the Norman Flats Dam there are about as many suckers and carp as Mr. Bengard has in New Mexico, but so far they have not been able to keep the game fish down. An excellent catch of bass and crappie have been taken from Roosevelt Lake and in fact this year the catch of crappies was tremendous, these fish running up to four and a half pounds and largemouth bass as high as twelve pounds in weight. In Norman Flats Dam, which was closed last January, there were young bass all over the lake. For example, I stood in one place with a fly and spinner and took twelve from six to nine inches in length as fast as I could cast. In the same waters with these bass were myriads of carp which move in huge schools round the shores. I think it would be a good idea for the state of Arizona to put in traps along the shores of these lakes.

BENEFIT OF REARING PONDS.

C. H. VAN ATTA,

Superintendent U. S. Fisheries Station,

Leadville, Colorado.

The use of rearing ponds for trout fry is becoming more extensive and practical in Colorado. Experience has shown in various cases that the planting of young trout or fingerlings, in the swift mountain streams does not produce the results that fish held in the natural rearing ponds, adjacent to the streams do.

The United States Forest Service in Colorado, has recognized the value of these rearing ponds, and has constructed about sixty, throughout the various Forest Reserves. They have been helped in this construction by Sportsman's Clubs and Isaac Walton Leagues.

Sometimes these ponds are made through the damming of streams by beavers, which are rapidly increasing in Colorado. As there is no expense to this kind of construction they make fairly good rearing ponds. There is some objection to planting trout in beaver dam ponds as all of the fish cannot be turned out of the ponds into the streams without considerable work, but this could be overcome by systematic planting, one pond being stocked one season and another the next, or if there is only one beaver pond on the stream, stock it one year and wait a year or so, before making another plant. In this way one locality would not be over stocked.

One instance of results from rearing ponds has come to our notice. The Empire Zinc Company at Gilman, Colorado, has constructed and maintained two rearing ponds, covering about one acre, along the Eagle River. In June 1924, ninety thousand brook trout, No. 1 fingerlings were deposited in these ponds. In July 1925, when the fish were turned into the Eagle River, with very little loss after the high water had subsided, they averaged five inches in length and were large enough to swim the swift waters. No expense of feeding or care was incurred by the company.

The Lake County Sportsman's Association have eleven rearing ponds located near the principal trout streams. In Half Moon Creek, near Leadville, where fish have been planted from the hatchery for years no results were observed until a number of rearing ponds were established. This season fishermen report that the creek is alive with trout four to six inches in length.

At the Leadville Station, where the water is very cold, seldom exceeding 50 degrees F. during the summer, the trout are hatched during March and April and fed on fresh ground beef hearts. Some of these fish were planted at Mt. Massive Club rearing ponds, as soon as the umbilical sac was absorbed. These ponds have an abundance of natural food, principally fresh water shrimps. The fish grow very fast and required no care nor feeding.

In the high altitude around Leadville the fry could not be planted in the rearing ponds before June or later on account of ice and snow, but it is our opinion that better results are obtained from fry held in natural rearing ponds with plenty of food where the fish early learn to hunt their own food. Hatchery-fed fish when liberated in streams are not used to procuring the kind of wild food upon which they must subsist.

Discussion.

MR. TITCOMB: Do you count the numbers of the larger trout that are released from the rearing ponds?

MR. VAN ATTA: No. These were not released from the main stream, but they told me that the ones from the Eagle River would average over five inches when they turned them out.

MR. FOSTER: What is the temperature of the water between the rearing ponds and the hatchery?

MR. VAN ATTA: In the rearing ponds, about 45; in the hatchery, about 40.

MR. FOSTER: It is hard to account for as great a difference in the size as you have indicated here, with such a small difference in the temperature of the water.

MR. TITCOMB: Was the pond that produced these nice trout a new pond?

MR. VAN ATTA: No, it is an old pond. It has been used since 1910, to my knowledge.

MR. TITCOMB: Trout in it every year?

MR. VAN ATTA: No, it is a spawning pond. When the spawning season was over last fall we took the spawners from this pond and the pond was dry all winter until this spring—just a narrow ditch running through it.

MR. TITCOMB: Mr. Chairman, that is a very unusual condition. These beautiful trout which Mr. Van Atta shows here look like wild trout. But I would not like to have that paper mislead some people or be used by them to establish the same things. There is some unusual condition there. It is a question whether it could be done every year. It would be well worth while to count the fish when they are

released and know more about it than merely see a lot of fish let out or see a lot of fish in there. Fish of that size look very numerous in a small place. I speak about this because I have seen some of the activities of sportsmen's clubs in connection with the rearing pond idea, where in some instances they chose a small stream, dammed it up and made a pool without cleaning up the natural enemies of the fish that are in it. There are almost always a few small trout in a pool of that kind a year or two older than the fish you put in. I have seen a plant confined to small springholes and practically starved to death. In one instance a club planted in long, narrow channels, which had once been used in connection with a manufacturing industry, some trout which I had sent for certain streams. I was skeptical about it and combatted the idea, which, by the way, had been started in New York state by a man who had never had experience in fish culture, and it was getting very popular among the clubs. I did not want to see the progeny wasted, and I went up and called on the president of the club. He took me out to the pools and called for the man who was supposed to feed these fish. This man was an angler, and he had his regular duties; and he took me out to illustrate their method of feeding. He took a chunk of liver or meat—I think it was beef—held a horseradish grater over the pool and began to grate this meat to feed about 50,000 trout.

I have no doubt that you will accomplish some good by this idea and I hope you will follow it up and see definitely what the results are. I am not seeking to criticize the paper which has been given; I simply wish to see to it that when the sportsman reads that paper he will get the other side as well and not be led into a serious error at some place where this cannot be done.

MR. VAN ATTA: From 1910 until 1916 we planted fish in these club lakes from the hatchery. We would take the spawn on a commission basis. The owner would do the seining and put them in the spawning pond; we would take the eggs and he would have fifty per cent. In eighteen months these same brook trout would be stripped again. We did that for six years in the place where these samples were taken. Two years ago we planted 10,000 native black spotted trout there, and they never had any on the place before. In May of this year they began to catch them, and they ran from 9 inches to 11½ inches. For the last month they have not caught a fish less than 12 inches long from among the natives of two years old. They have twenty-two lakes on the place and a rearing pond in connection. This lake in which the natives were put is about twenty-two acres, mainly brook trout.

MR. TITCOMB: I would like to get hold of a place like that.

MR. CULLER: I do not think there is anything unusual about the size of the fish; it would apply to any pond in the United States where fish are placed and properly fed—an earth bottom pond. Some years

ago we tried an experiment with fish twenty months old; we raised rainbow trout and spawned seventy per cent of the females. That experiment was carried on at Wytheville, Virginia, some years ago. I think there is no doubt whatever that fish can be raised to that size in any place where they are properly cared for. At Winona there are a number of pools where they are trying the same experiment out and for a number of years have had unusual success. One trouble with the clubs in the country is that they will put more fish in the stream than the stream will support.

MR. TITCOMB: I do not believe that Mr. Culler has grasped the idea. The fish which have been referred to are all getting natural food only.

MR. CULLER: I understand that, but I say the same thing can be done under control and the fish fed at the same time.

MR. TITCOMB: Then you have the same conditions that you have in the hatchery.

MR. CULLER: Certainly.

MR. CARPENTER: We had an experience with pond-reared fish in Montana. The Hamilton Sportsmen's Club in 1923 released several thousand fish from two rearing ponds, the fish being six inches long, so they told me. I asked Bill Kennedy, who supervised the liberating of the fish, if they were not stringing me as to the size of them, but he said, "Absolutely not; I will swear some of those fish were seven inches long." The Bozeman Rod and Gun Club from one rearing pond liberated several thousand that were five and a half inches long. In neither case did they have any artificial food. I do not know what age they were or at what time of year they were liberated.

MR. BENGARD: I have had a little experience in bringing fish from fry up to fingerling size, and I find that the greatest trouble confronting us is the question of food. Several years ago I was superintendent of a hatchery in Colorado. The Game and Fish Department leased a pond from the Lost Lake Trout Hatchery Company. The pond had been empty for two or three years, and part of that time it was dry. It had been filled up for about six months when we put these fish in. They bought these fish from the Lost Lake Trout Company, put in 112,000, left them there twelve months—and such results you never heard of; they ran all the way up to five or six inches long. We did not count them, but I would say without exaggeration that we took out at least 70 per cent of what we put in. Well, they all went wild about the nursery pond business. My boss said to me, "Bengard, put all the fish you can spare from your hatchery into that pond. That is a wonderful proposition." So I was obedient: I put 100,000 fish in there. As a rule these fish men will stretch a little bit when they come to putting fish in and cannot count them, but I was so enthusiastic that I put in a good many. This was a pond, I daresay, of three or

four acres, and it had never been built with an idea of getting the fish out conveniently; it had deeper holes out in the middle and several places that were sort of pockets. So when the boys got these fish out they seined around until they got tired and said they had them all out. But when I came to put the fish in the next year the pond was just boiling all up; the fish were jumping up catching mosquitoes. I had not had a great deal of experience in the nursery pond business, so I paid no attention to it, but I had occasion to remember my mistake afterwards. I put in 100,000 fish. A year after that the boys went to take them out, and what do you suppose they found? They found about 200, about twelve inches long. They swore I must have taken the empty cans out there and had not put in any at all.

The nursery pond proposition is very much to the front in fish culture to-day. Everybody down in New Mexico wants nursery ponds. They want to dig a hole in the ground, run a stream of water into it and fill it full of fish. Well, that is all right, but if you build a pond without making provision for food, run water into it and then put your fish in—say little bits of fry, all the same size—and leave them there six months, if you take out 20 per cent of what you put in you will do well. They will eat one another up. Just how to feed fish in a nursery pond out in the country is a question. You cannot have all these nursery ponds at the hatchery, for the simple reason that you cannot stand the expense of transporting fish four or five inches long hundreds of miles from outlying points. So in New Mexico we are building ponds—we have built four in the last three months—away out in the country; but the food question still remains unsolved. I have this suggestion to make: If I had my way about it I would build a number of ponds, fill them up with water and forget that I had them for two years; then I would put a few fish in them. If you make arrangements with a forest ranger or farmer to feed these fish he will probably go along the pond about once a week and throw in a handful of food. That is not satisfactory at all; if you are going to feed the fish artificially it must be done regularly. We have thirteen nursery ponds at our hatchery and we feed those fish three times a day. We have one pond there which is set aside as a kind of show pond; they are the first fish that were hatched in New Mexico. They were three years old the first week in March and they will weigh a little better than five and a half pounds. They are rainbows, and they have been fed regularly. They get all the stuff that the other fish cannot swallow: I put in there all the dead eggs and all the dead fish and liver that I did not grind fine enough for the little fish. I have another pond in which there are steelheads which were a year old the first of June or the last of May. I had 25,000 in that pond but I have only 5,000 or 6,000 left. It is no trouble at all to find the eight and eight and a half inch fish there. But they have been fed. I believe in natural

food, but as one of the gentlemen here has said, if you will feed artificial food regularly the fish will grow just as fast. There is no telling how big you can make the fish grow in a year if you feed them regularly. We have a temperature of water of about 54 degrees down there, and you can almost see the fish grow from one month to another. They get to five and a half or six pounds in three years, confined in a pond 12 by 50. But the feeding of fry up to the fingerling size away out in the country is a problem that I have never been able to solve and I would like to hear from somebody who has tried it out and who knows more about it than I do. I am very much interested in it.

MR. BRUNSON: Up in Montana, while I was superintendent, my idea was to have natural ponds that could be drained bone dry after we drew them down and let the fish go. My plan was to take the fish when they were about a week or ten days old, before the sac was absorbed, and place them in the ponds. Of course some were very zealous in the matter and they would want to take any old hole that had water in it, even though it could not be drained, and use it for a rearing pond. But the ones I had to put in were smaller than No. 2 and up to No. 4. When they drew the ponds down they never counted the ones that came out so that there was nothing to show what the results were, and it is my opinion that there were less taken out than were put in.

MR. TITCOMB: The solution, it seems to me, is to leave to the fish culturists the question of the number of fish that should be allotted to a stream. Whoever is in charge and has knowledge of the situation should make the allotment, and the sportsmen's associations should abide by it. Of course if they buy fish on their own account and put them in, that is another question. But I am entirely in sympathy with Mr. Culler's idea that in many places they do overstock the streams. In Connecticut we make allotments definitely as to the number of plants each stream will get, and that is all they get.

MR. CULLER: I think the only practical solution of the question of stocking is a scientific survey of all the streams, either by the state or by the state and federal government in co-operation, and the making of all allotments on the basis of their reports. I do not think we will get very far until there is an absolute stream survey made of the whole country.

MR. TITCOMB: I have a series of topographical maps in connection with a survey we have just completed of the state of Connecticut. We followed out on the map the entire watersheds. We indicated with a red ink line the waters suitable for brook trout. We indicated with sepia color the waters that we decided were more suitable for brown trout, on account of the high temperature. We marked with blue the posted areas—and there are a lot of them—showing portions

of streams which the state will not stock. We marked with purple the polluted areas. Then we had our lakes labelled with a key to indicate the types of fish for those. We will make from that a card for each one of these streams and each tributary, referring to the map, and a typewritten report will be filed covering all the cards. There is another card which is a stocking record for the past few years, and all future records will be added to that. When this is completed any clerk in the office will be able to make allotments of fish, because we have decided just what we will do with each stream as to the number of fingerlings that will be allotted. We allot by cans instead of by the number of fish, because the number of fish varies according to the size at the time of distribution. In that way we expect to have in the office a sort of fool-proof index. Of course we shall have to review it occasionally and make a note of what waters have changed through pollution being cleaned up—now that we have a Pollution Commission; of waters that have been absorbed by clubs and individuals who are posting, and so on. It is a very interesting survey; I think it is the most interesting one I have ever seen. Dr. Belding is working with us this month and he says it is the best thing he has ever seen, and he has done quite a little of that work.

MR. CULLER: We have a similar practice to that for the planting in Yellowstone Park, though of course it is on a smaller scale. But we have the areas marked off—a green area, for instance, where we plant the natives, and another area in blue for the brook trout, and nothing is planted in those streams except these species. We are trying to keep the different species in the streams in which plants have been made in the past.

MR. SURBER: In Minnesota, so far as the state is concerned, we are absolutely opposed to this pond feeding by clubs of any description. I think it is unreasonable to believe that they get results that would amount to a row of pins by feeding once or twice or three or four times a week fish that we have absolutely determined require feeding three or four times a day to produce any results in a hatchery. This is particularly true when we take into consideration the area of the small ponds that they are able to build and the number of fish that they place in them. If they are buying the fish of course it is their own business, but they do not buy them; the bulk of them are obtained from government or state hatcheries, and I have absolutely turned down applications where I know it is the intention to put fish in such ponds. It is ridiculous that the state should go to the expense of rearing fish to small fingerlings and turn them over to these men, only to have them disappear by cannibalism. It will not work.

MR. Lecompte: With reference to overstocking, unless the state makes a survey of streams I do not see how it is possible to know whether there is overstocking or not. I have been after the Commission since 1916 to have a survey of the streams made in our state, and

finally, under the administration of Mr. Earle, we have started that survey this year. Mr. Tressler, former game and fish commissioner of New Jersey, is making the survey for us, and before I left he had reported on the County of Carroll. In streams in which thousands of fingerlings have been planted he absolutely recommended the planting of no fish whatever; they would not support any species. The state has been wasting money, and all states, unless they make a survey, are going to waste money on streams when they do not know what they are doing. That is exactly what we have been doing. For the past forty years they have been planting different species of fish in streams that would not support any species. The survey shows that we have planted bass and crappie in the waters of Carroll county where there should not have been a fish put in any of the streams planted. In the first place there was not enough food for them, and in the next place, these streams were polluted by refuse from manufacturing industries and by the sewage from the towns and would not grow the necessary vegetable matter to support the fish. I do not think any of us know anything about understocking or overstocking in the absence of a definite survey.

MR. COBB: In my experience I have never known one instance in which a club actually fed fish in such a way that they got the benefit from the food. I would cite one instance, without giving the name of the place, in which a pond was built and a man running a power plant volunteered to feed the fish. We put in quite a number of fish, all I thought the place would stand. In the morning this man would put a piece of liver in a sausage cutter, turn it once or twice, and then put the sausage cutter down in the pond. If he came out again the same day he would give it a few more turns. The fish grew a little, but they were pretty big in the head and small in the body. One day I went up there and they wanted me to see the fish. I went up and I saw a lot of fish that looked very different from those that they had had the time before; the pond was pretty full. I asked them where they got them, and they said they managed to get a carload from the Bureau of Fisheries. They were not the same size as the others they had before, but they were put in the same pond. The sausage cutter was still operating. And I should say that that man took better care of his fish than almost any other man I ran across.

MR. FOSTER: The chief question in this rearing pond business is that of proper supervision. If these clubs are near enough to a state or government hatchery where they can get proper supervision and it can be seen that the fish are properly fed, it is a good thing; otherwise not.

MR. TITCOMB: Otherwise employ a fish culturist.

MR. FOSTER: Yes.

NOTES ON CERTAIN DISEASES OF RAINBOW TROUT.

BY FRED J. FOSTER.

MR. FOSTER: Before starting this paper I have a word of explanation to make. I was unfortunate in not being able to attend the last meeting in Canada and I did not receive the copy of the Transactions of that meeting until after this paper was written, consequently part of this paper devoted to Gyrodactylus was largely covered by Dr. Embury's paper at the last meeting. So that while there are one or two points that may be of interest, the bulk of that subject has already been covered. I also wish to say that in regard to the treatment of that at Mr. Hayford's hatchery, they have carried it on farther than I have, and with the glacial acetic he worked out the correct proportions with correct timing, so that the microscope would perhaps not be necessary to the average fish culturist on treating for Gyrodactylus.

The fluke parasite, Gyrodactylus, made its appearance at the Neosho Missouri station of the Bureau of Fisheries during the early spring of the year 1922, and each year since then, during the late winter and early spring, its presence has been the source of much annoyance, as it is particularly persistent, reproduces rapidly and unless remedial measures are taken is very destructive to fingerling trout before they reach a length of four inches. It does not appear until after heavy rains which would indicate that the disease may be earth borne.

As a rule, the parasites are first seen upon the tail and anal fins and are readily distinguished with a low power microscope or even with the naked eye when one is familiar with them. The Gyrodactylus is viviparous and the young frequently may be seen within the adult, the "hooks" being most apparent. Unless the infested fish are given treatment the parasites will in a week or two develop in hundreds and form a fringe upon the fins. Subsequent attacks are as frequently upon the body of the host, the greatest numbers attaching themselves just behind the pectoral fins. They are more difficult to distinguish when upon the body and unless careful weekly examinations are made the fish may become heavily infested before one is aware of their presence. They may be readily removed for examination by scraping a cover glass down the side of the fish.

Unlike many diseases of trout, fish infested with Gyrodactylus show few marked symptoms until in the last stages. Some darting or scraping of the side upon the bottom of the trough or pool may be seen but otherwise the fish act and feed

normally until the fins have been eaten away to a degree to affect the movements of the fish or the body slime has been removed over a considerable area. Then the fish become listless, seek quiet corners away from the current, cease to feed and soon die.

I wish to stress particularly the importance of an immediate and thorough examination upon the first indication of darting. It is an almost unfailing indication of the presence of parasites in some form; usually *Costia necatrix*, *Gyrodactylus* or *Ichthyophthirius* and no time should be lost in diagnosis and treatment.

Upon the first attack of the trouble in 1922 a number of different methods of treatment were tried including the use of potassium permanganate and mercurochrome, none of which were found effective until a solution of pure cider vinegar was used. It was at once apparent that a small quantity of vinegar in the water quickly killed the flukes and experiments demonstrated that a 1 to 15 solution would effectually destroy them in 8 or 10 seconds. It was soon found, however, that commercial vinegar varied considerably as to strength, some being so strong that a 1 to 30 solution is sufficient while other lots were so weak that a 1 to 8 solution was required. Later experiments proved that a 2½ % solution of acetic acid was effective in from 10 to 12 seconds without injury to the fingerlings but as the cost was somewhat higher we have continued to use the cider vinegar.

It was afterwards learned that probably the first use of vinegar in fish culture work was by the late George A. Seagle at the Wytheville, Va., station, many years ago and the "Fin Disease" for which it was used was no doubt *Gyrodactylus* which at that time had not been identified.

When vinegar is used, the use of a microscope is practically a necessity in determining the correct strength of the solution and length of time the fish should be held in the dip. It would be well to start with a 1 to 15 solution and immerse 5 or 6 fish for 15 to 20 seconds, returning them immediately to fresh water. The fish will show considerable distress for the first few seconds after being placed in the dip and then become more quiet. Some may turn on the side and even remain in this position for some time after being transferred to fresh water, but if the dip is not too strong they will recover in two or three minutes. In no case should the solution be used strong enough to cause the natural slime on the fish to turn white. After the fish have been in fresh water for a few minutes they may be examined to determine if the

parasites are dead. If so they will appear shriveled and less transparent and, naturally, without movement, in contrast with their active gyrations when alive. A few may have dropped off in the solution or brushed off by contact with the net but the majority will still be clinging to the fish by the embedded hooks. It may be found necessary to make several such tests until the correct proportions are found for the solution. Usually a solution of such strength that a fish can remain in the dip from 15 to 20 seconds without injury but one that will effectually kill the parasites, will be the most efficient and permit rapid handling which is an important consideration when a large number of fish are treated.

After the correct solution strength has been determined, a quantity may be mixed in a tub or other suitable container and a bobinet dip net with deep bag used to retain the fish in the solution. Care should be taken that too many fish are not handled in the net at one time as injury may result to those beneath from the weight of the mass and there should always be plenty of room for the fish to move freely about in the solution. Likewise, the dip should be convenient to the troughs or pools from which the fish are taken to those to which they are to be transferred so that no time may be lost in getting them into the dip and thence to fresh water. Especial care should be taken that the fish are not crowded in a tub, trough or pool corner to the extent that they lack oxygen and the vitality lowered before being immersed in the solution or losses will result.

When a large number are to be treated it will be found necessary to add small quantities of vinegar during the dipping operation to make up in the loss in strength of the solution from the transfer of water from the fish. With this method and a convenient arrangement a surprisingly large number of fish can be handled in a short time.

When all the fish have been removed from the trough or pool it should be thoroughly cleansed and sponged with a strong vinegar solution before again being used. Naturally, there will be a somewhat larger loss than average during the first twenty-four hours after treatment. The severity will depend upon the extent the fish were infested. The succeeding 24 hours will show a marked improvement.

If the parasites are continuing to be introduced through the water supply it may be necessary to repeat the dipping every two or three weeks until the fish have attained a sufficient size so that the natural slime is thick enough to afford protection. Fish over $4\frac{1}{2}$ inches in length are usually able to withstand the

attacks of this parasite without loss or apparent discomfort. The smaller the fish, naturally, the more rapid the destruction of the slime and tissue.

A destructive disease causing the disintegration of the kidney with crystal formations has been experienced in several Missouri hatcheries during the past few years. I understand that it also has been noted at the Erwin, Tenn., station of the Bureau of Fisheries. The disease makes its appearance when the fish have reached the length of $1\frac{1}{4}$ inches, regardless of the time of year, water temperatures or other conditions. The symptoms are quite marked; in typical cases the gills first become pale and in advanced stages lose practically all color, the body of the fish turns dark and frequently the head is distorted. The light color of the gills is the first symptom of the disease. This may continue a week or more before other symptoms develop, but once any other external symptoms are apparent death is only a matter of less than a week. Shortly before death the fish either rises to the top or goes down to the bottom of the trough or pool and ceasing to feed noses along the side or floats listlessly. The kidney is light in color and under microscopic examination disintegration is shown and the presence of minute crystals of glass-like appearance. These may readily be seen when fragments of the kidney are placed under a microscope magnifying 375 diameters, although seldom can more than two crystals be found within the field at one time.

This disease seems to be an inherent predisposition as it only develops in fish reared from Missouri grown brood stock and hatched at certain points within the state. No report has ever been received of its development where our eggs have been shipped to other states and neither do we experience it in fish hatched from eggs shipped to us.

At no time does the disease become markedly epidemic but the losses extend over a month or two and have resulted in the death of as high as 80% of a given lot of fish. As a rule, the greatest losses will occur before the fish have reached a length of two inches but may continue until the fish are as large as 4 inches. Unless the first symptoms appear before the fish are $2\frac{1}{2}$ inches in length it has never been known to develop.

No cause for the disorder has yet been determined. Lowered resistance as a result of too rapid growth and deficiency of certain vitamins in the diet are suspected. The abundance of calcium in the water is also under consideration.

Measures so far adopted for the control of the disease have not been entirely successful. At the Erwin station some re-

lief was reported by thinning the fish in the troughs, but this method, however, had no effect at Neosho. The transfer of fish from the hatchery to the open pools where they received direct sunlight shortly after they start feeding seemed to lessen the severity of the attack and considerably lowered mortality.

In a recent feeding experiment a given lot of fish were fed on the commercial product known as Ceromealo which is dried brewer's yeast and cod liver oil. While these fish developed much more slowly than the controls which were fed the customary diet of beef hearts, they did not develop the kidney disorder which seriously affected the control fish. This measure offers what appears to be a practical method of prevention and further experimentation along this line will be made. A measure of success in combating the trouble has been obtained by rearing brood stock from wild eggs shipped from Montana but this precaution did not entirely eliminate it. It is felt that a combination of the measures that have proved beneficial, i. e. broodstock developed from wild eggs, early transfer to sunlight after starting to feed and a more nearly balanced diet will eliminate this troublesome disorder.

A nervous disease for which the writer has found no parallel has been present in Missouri for the last few years. This disease may attack the fish at any time when they are from one to two inches in length with fatal results and cause marked symptoms in somewhat larger fish.

The first symptoms may be easily overlooked by the fish culturist. They are slight falling off in feeding and nervousness upon the part of the fish when any one approaches or any disturbance takes place within their sight. This continues for a few days with increasing nervousness but continued light feeding. The fish go into the second stage without warning upon the slight disturbance. The swift passing of the hand over the trough will cause a stampede in which ten or a dozen fish will suddenly be convulsed and after gyrating for a few seconds sink dead to the bottom of the trough. The sudden removal of a cover at this stage will frequently cause the death of 30 to 40 fish. During the convulsion the mouth is open and gills distended. In death the mouth and gills are frequently closed but the most striking condition in by far the majority of cases, is that the dead fish are curved in a crescent shape as if by contraction along the lateral line.

Another strange coincidence in connection with this disorder is that it will affect certain troughs of fish and not others. It may attack the fish in an upper trough and not those in the

one below, both containing fish of the same hatch, or it may attack every trough of fish in the hatchery over a period of several weeks or all simultaneously. During the past season it was experienced in four hatcheries in Missouri.

Fortunately, efficient remedial measures were found. As soon as the first convulsions appear the trough is darkened with a tight cover and no food is given for from 36 to 48 hours. During this time absolutely no disturbance whatever is permitted near the trough and the cover remains tightly closed. At the expiration of this period the covers are slowly and gently removed, preferably in the late evening and without the presence of light. Thus the morning light will gradually penetrate the troughs without the suddenness that would be caused by removing the covers during daylight hours.

During the ensuing 24 hours the fish are given three light feeds of clabbered milk. This may conveniently be fed by placing it in a fine mesh strainer and gently shaking in the trough. The following day two light feeds each of milk and meat, may be fed alternately. The third day the losses will have dropped to normal and the customary diet and feedings be resumed.

When these measures are used the losses are seldom over 8 per cent, but when not adopted it has run as high as 55 per cent.

Discussion.

MR. HAYFORD: We have a good deal of trouble with this parasite at our station, and as Mr. Foster informed me that he had his microscope here with some specimens, I thought it would be well to bring his paper up as early as possible so that fish culturists could become acquainted with the appearance of the organism through the microscope.

MR. FOSTER: I would like Mr. Culler to say a few words in regard to the last disease I mentioned, and in reference to a disease which Mr. Keil also mentioned. A condition of carbon dioxide in the water is attributed to be the cause at one or two other points. This is the first I have heard of anything like that, but it develops that this disease has been experienced at a number of different places. Mr. Ainsworth says there is a possibility that they have had it recently at Saratoga. I think the matter should be given a little discussion, because if we can find a cause for it and eliminate the cause we are so much better off than trying to treat the disease after it has made its appearance. If it is due to supersaturation of carbon dioxide in the water, measures can no doubt be taken to eliminate it. In Dr. Davis' discussion of last year he mentioned that in a control feeding experiment in which carp

were given no vitamin B they showed corresponding symptoms. That would lead to another possible solution.

MR. CULLER: Last night after the meeting I was talking over this disease with Mr. Foster and telling of some of the troubles we had some years ago at the coast and of an experiment conducted at Homer. I was not at Homer at the time the experiment was conducted, but the trouble was diagnosed by the former scientific assistant at Homer as super-aeration, I suppose—carbon dioxide—and the remedy we applied was complete re-aeration of the water. Yellow perch taken from along the Mississippi River showed the same symptoms. After being in the tanks from six to twelve hours a sudden jar in the tank would cause distention of the gills and curvature of the spine, whereupon the fish would turn over on their sides and die. I cannot just get the two diseases straight in my mind, whether they are similar or not, but the symptoms are alike.

MR. FOSTER: I think this is a very important point. At these two hatcheries in Missouri we will have an analysis made of the gaseous contents of the water at the time we are experiencing the trouble, and we will set up reaerating devices. If we can eliminate the disease it is going to save the lives of a lot of fish and do more than we can ever hope to do in the way of corrective measures after they have the disease.

MR. CULLER: One strange thing happened at Lacrosse. We noticed it in the first trough where the water enters. The water is used a second time in a lower trough. The fish in the upper trough would show no signs of the disease while those in the lower trough would, and vice versa. That was a peculiar thing about it that I could not understand.

PRESIDENT COBB: Would it not be true that identically the same symptoms in different places might be brought about by different causes? I take it that anything that tended to weaken the fish in any way would make them susceptible to this trouble, and where you find it in one trough and not in another it is more than likely that the fish in that one trough are weaker than those in the others.

MR. FOSTER: That would be possible. Lowered resistance in any given point would make the fish susceptible to this condition, although you would have to have one specific condition present in all cases in order to produce it. Lowered resistance along any lines would tend to aggravate it.

MR. LAIRD: I would like to speak about a disease we had among brook trout and get some information on it if I can. During the latter part of June a worm attacked my three-year-old brook trout. I wrote Dr. Davis about it and he called it *Octobothrium*, I think. A brown worm about three-tenths of an inch long attached itself to the gills of the fish and sucked the blood so that in a short time the fish had no strength and turned over. Dr. Davis recommended the use of vinegar,

fifteen parts of vinegar to one hundred parts of water—about one to seven. I tried that but found the results to be unsatisfactory; in fact, I lost thirty-four out of a hundred. I then tried about one part to fourteen, and I found that while that would not kill the fish it would not kill the worm either. The thing I did was to turn all the fish into a pond, and I had no loss whatever after that. I would like to know whether anyone else here has had anything to do with a gill worm that gave them any serious trouble, and what is the remedy, if any.

MR. SURBER: At the Glenwood hatchery last season one pond of brood stock three years old were attacked by this same worm. I recommended a vinegar treatment and that met with immediate success, without the loss of more than about one per cent of the fish. I think we had about three or four thousand attacked by this gill parasite. The strength we used was about one to fifteen.

MR. LAIRD: Mr. Leach told about the diversity in the strength in the different vinegars. I bought a barrel of vinegar, and it must have been very powerful.

MR. SURBER: You probably got acetic acid. We obtain the cider vinegar.

MR. LAIRD: This would turn the slime on the fish blue in just a minute, and they would turn over helpless.

MR. TITCOMB: If you take a barrel of cider and don't drink it but let it work, testing it from time to time, until it turns to vinegar, you will find it very good to use in the way Dr. Davis suggested.

MR. LAIRD: In my case it happened in the cleanest pond I had. I let the water down so that there was very little in it and then turned a bucket of clear vinegar into the top end and let it run through the system—I had a foot of water. Then I put in about two hundred pounds of rock salt. In the next couple of weeks the worms seemed to diminish so that there was no further loss.

DR. EMMELINE MOORE: Would it not be safer to get some standard solution of acetic acid rather than use the old-fashioned vinegar as a remedy?

MR. HAYFORD: With regard to this acetic acid, Dr. Embury spent ten days at our hatchery and we worked out some of these things. We had the thirty-six per cent strength that we got from the drug store, and then we used the glacial acetic. We are using glacial acetic altogether. It is the easiest remedy by far to use, because you know exactly what you have. It is ninety-nine per cent, almost one hundred. We have not found a parasite that glacial acetic will not kill on contact. We find in the case of trout from three to five inches long we can use one c. c. in 490 of water.

DR. EMMELINE MOORE: For how long a time?

MR. HAYFORD: A submerging of about forty to sixty seconds. We find that sometimes with the smaller fish we have to work up as high as one c. c. to 1,000 c. c. of water. It depends a good deal on the fish.

Before we start to use it in any considerable quantities we test it out with just a few fish. I tried four ponds just before I came here, and I found that while some of them would stand a minute to a minute and a half of submerging, others would not stand thirty-five to forty seconds. The method we find the quickest and best is as follows: We take some fine netting, according to the size of the fish we are dipping, and make it up into a pocket net. We then take a large washtub and put in the proportion of water that is required. One of the boys holds the watch and the other dips up. The minute a netful of fish drops into the tub the man with the watch catches the second, and after forty seconds, if they show any signs of tipping, they are dumped. If they are standing up in sixty seconds he lets them go. In that way we treat 100,000 trout two inches long a day, 15,000 to 20,000 fish three to four inches long and from three to five thousand fish of eight to ten inches. We seldom get a recurrence under three or four months. We do not find many on the brown trout, and very seldom see it on the rainbow, but the brook trout become heavily infested. But we do not worry any more about it. If we find it prevailing to any great extent we treat it, but if we find only one or two we do not bother about it.

DR. EMMELINE MOORE: Do you clean your ponds afterwards?

MR. HAYFORD: Yes, with chloride of lime and different things. But the quickest and cheapest way out is to give them a dose and be done with it. Dr. Embury told me the last time he was at the hatchery, in June, that up to the present time he had not found any external parasite that the acetic acid would not immediately destroy.

DR. EMMELINE MOORE: What is the formula, again?

MR. HAYFORD: The formula of glacial is, for trout three inches up, we will say, one part to five hundred. We can work that at times down to one part to four hundred, but we have to test it out. For your smaller fish, fry, we will say, up to fingerling, an inch to two inches, you have got to work back and forth from one part to seven hundred and fifty to one part to a thousand—it varies. We use it as strong as we can. With the thirty-six per cent we start in on a proportion of one to one hundred and seventy-five. Now we have it down to one part to one hundred with the larger fish.

MR. TITCOMB: How often would you change that dip in the tub?

MR. HAYFORD: Sometimes if the temperature is cool we treat a whole pond of fifteen to twenty thousand without change. Of course we keep churning it up with the hands to keep it oxidized. On a warm day you cannot let the temperature jump from 52 up to 65; the boys watch the temperature and do not let it vary more than two or three degrees. The fish go in and out so quickly and are there such a short time, only from forty to sixty seconds, that lack of oxygen would not have so much effect as change of temperature. If there is a change from 50 to 70 degrees, when they go back into the ponds they do a lot of wobbling

around, but if the temperature is kept uniform they will generally be all right.

MR. TITCOMB: Your solution becomes slightly weaker each time, does it not?

MR. HAYFORD: We add to the solution from time to time, as we get a quantity of water coming in with the net. We would put in perhaps 10 c. c. after we had worked it say half an hour. But with the glacial you have to get your proportions right; you cannot afford to make any mistake. A little four ounce bottle will last you all summer.

MR. LAIRD: What is the trade name of that mixture?

MR. HAYFORD: Glacial acetic acid. Any drug store has it.

MR. LAIRD: I found that the worm seemed to hit just the big fish and in the cleanest ponds I had—clean fine gravel, no excrement, no mud or anything else.

MR. HAYFORD: We have 190 ponds, scattered all about. We simply go by the actions of the fish. You might have it in the tenth pond and not in any of the others. We figure we always have some of these things in five or six of the ponds. We just watch it and see that it does not get the upper hand.

MR. LAIRD: My fish would not show signs of distress but they would not eat.

MR. FOSTER: Is Mr. Hayford not referring to *Gyrodactylus*?

MR. LAIRD: I am referring to worm in the gill.

MR. HAYFORD: In my state we have three or four different parasites.

MR. FOSTER: Did you hear the first remarks Mr. Laird made in regard to the worm in the gill?

MR. HAYFORD: Yes.

MR. FOSTER: I would like to ask Mr. Surber what size of fish he found this gill worm in?

MR. SURBER: They were about ten inches.

A WORD IN DEFENCE OF THE "DOUGHTY SCOTCHMAN"

S. M. AINSWORTH.

Perhaps some of you will say that the Loch Leven trout, (*Salmo trutta Levenensis*) needs no defence, being perfectly able to take care of himself, which is more or less true. However I think in many localities he is a very much abused member of the trout family. Because he is so hardy and will endure so much more than the other members of the trout family, he is accused of being voracious and cannibalistic. So far as I have been able to observe he is not guilty of either accusation. To one who continually has the care of either young fish or brood stock it is a noticeable fact that Loch Leven trout do not consume more food than others of their own size. Neither is their cannibalistic tendency more in evidence. It is a well known fact that no trout will hesitate to indulge in a trout dinner if pressed with hunger, even though the victim be one of his own kind, and so far as I have been able to observe the Loch Leven species is neither worse nor better than the others in this respect.

The young seem less susceptible to the diseases that so often afflict fry and fingerlings in the hatching trough or rearing ponds. Also the adult fish do not seem to suffer from the various afflictions that so often assail the brood stock of other species commonly held at the hatcheries for spawning purposes, thus making it much easier to keep on hand stock for propagation.

I have a theory that the Loch Leven trout being more hardy than other species, where there is limited space or food supply, will survive longer and eventually obtain food when the other fish have become too weak to search for it. Again it is not above bottom feeding when there is a scarcity of food to be obtained otherwise and will thus survive and even thrive where others can scarcely exist. It is freely admitted that under adverse conditions the Loch Leven may in time crowd the others out, but given plenty of room and food other trout will thrive in the same waters, provided that temperature and aeration are suitable. The Loch Leven trout will exist under a wider variation of temperatures and with less aeration than most of the other species of trout.

Their eggs are as easily secured as those of the brook trout or blackspotted, or redthroat, as Dr. Van Dyke justly calls them. Also the eggs are more hardy than those of other species.

The writer on one occasion having been detailed to the work of opening a Loch Leven spawn collecting field, in hopes of being able to obtain from two to three million eggs, was fortunate enough to collect some 7,700,000. But with equipment for handling three million and nearly eight million to care for, it was necessary to use every available container, whether suitable or not, with the result that a few takes were practically a total loss. In spite of these losses approximately ninety per cent of the total take was eyed and shipped to the main station where it was hatched or repacked and shipped to other Federal or State hatcheries.

Many anglers put forth the claim that the Loch Leven trout are not so gamy a fish to hook as some of the other trout, but probably as many more, equally good anglers, are just as favorable to the Loch Leven species and I have observed that all are very much pleased when they can land a wiley four or five pounder.

Please do not take it from this little defence of them that I would advocate the indiscriminate planting of Loch Leven. In water that is now stocked with any desirable trout exclusively it would seem better if possible to keep it for that one kind, especially if it be a Redthroat as in Yellowstone Lake, where in my opinion it would be almost a crime to plant *any* other *fish*, unless it be some variety of minnow to augment the food supply and I hardly think that necessary. Many of our mountain lakes are inaccessible to other waters and it would seem good policy to stock them with one kind of trout and restrict the planting to that one species.

In waters of large area, accessible to other waters there can be no objection to planting several different kinds. One lake with which the writer is quite well acquainted is stocked with brook, rainbow, native and mackinaw trout and suckers. All these species are flourishing, the suckers best of all, although many suckers were seen with only the tail visible, the balance of the fish being well within the mouth of some trout.

In these days of rapid travel there is so little water that may be considered remote or isolated that it is essential that some hardy trout difficult to catch and easy to propagate be planted in order to maintain fishing as an interesting sport. To my mind there is none that can successfully compete with the "Doughty Scotchman" in all these particulars.

SCOTTY COMES BACK.

W. T. THOMPSON.

You men of the east, and you of the Great Lakes region have long waged war against the evils of deforestation and pollution of your splendid trout waters. Your choicest forest is now a thing of the past; the glory of your splendid trout streams has partially vanished. The conditions for trout growth are not now, and probably never again will be comparable to what they were when your countries were new. Your clear crystal streams, with mossy shaded banks are largely memories of the past.

We of the great Continental Divide region and of the farther west are now in the midst of our battle against deforestation and pollution, and we are profiting in some small measure at least from your struggles and your experiences. Public sentiment has been aroused to the economic crime of destroying the protective coverings of our great watershed areas.

Most fortunately, we outdoor lovers, anglers and fish-culturists of this high divide country lying along the foothills of the great Continental Divide are most wonderfully blessed in that a large proportion of our forests have been protected from the usual wanton spoliation through being included in our National Forests and National Parks. These mammoth watersheds are thus for all time set aside and freed from the menace of deforestation and pollution, besides being assured of a reasonably intelligent control and development.

Here then in these streams, lakes and constantly increasing number of reservoirs of our wonderful Rocky Mountain region will be found the trout refuges of the coming ages. Here our aristocratic native redbreast and the grayling will continue to make their homes. Here too are now thriving, and will continue to thrive, the Prince of the East, the speckled trout of the Atlantic coast and the Great Lakes region, likewise the Sultan of the West, the dashing, spectacular and hard fighting rainbow of the Pacific Slope. Possibly it may be news to some of my hearers to know that even now more eggs from wild fish of these varieties are being secured in the open streams and lakes of the Rocky Mountains than from their old home waters.

Notwithstanding these exceptionally favorable conditions, we are not free from the problems incident to deforestation and pollution. Our cultivated area is increasing. Irrigation takes its toll of our streams. To a markedly lesser degree does the initial water supply for the lower areas of our streams flow over natural pastures and meadow lands. The rains now

carry much silt; the returning irrigation water increases turbidity on the lower streams. The Yellowstone, the upper Missouri and the lower Madison, Gallatin and Jefferson, which unite and form the Missouri, are no longer such attractive habitats for our finny aristocrats as in the days of the Indian and the buffalo.

The angler living along these disturbed waters has long been perturbed over his lessened catches. Fish culturists have debated the solution of the problem. There can be no question that our industries are here to stay. Lumbering, mining, agriculture and manufacturing are highly essential to our local, as well as our national welfare. In time, unquestionably the evils of pollution from these sources will be materially lessened. But what of today and tomorrow, questions the eager angler?

Various solutions have been suggested, the men from the Great Lakes region advocated the introduction of the black bass, whilst those from the Mississippi Valley urged that our salvation lay in the introduction of the river fishes. Neither plan met with the general approval. Consequently nothing was done. Whilst the angler and the fish culturist debated the matter in more or less heated discussions—*suddenly*—The unexpected happened—*Scotty came back!*

Up in our country in Montana, in the "Land of the Shining Mountains," we are pleased to call this hero of the debatable waters—the Loch Leven. I am not prepared however to claim that he is of the simon-pure strain but there is something about this name which appeals more strongly to the imagination of our mountain men than does the more general and possibly more correct designation, the European Brown Trout. We vision the "Bonnie Scotland" of our forefathers, with its beautiful lochs, rivers and friths, and the boundless sweep and rich feeding grounds of the surrounding ocean. Here, rather than in the more sluggish inland trout streams of continental Europe, are found those ideal conditions necessary for the development of an ancestry worthy of the twenty and twenty-five pound specimens which are frequently caught in the Yellowstone River in the vicinity of Livingstone, as well as the somewhat smaller, but more abundant Loch Leven of the Madison Valley where the United States Bureau of Fisheries secured twelve million eggs from the wild fish last fall, and eight million during the experimental operations of the previous season.

The success of any new movement, or of any candidate for public favor, is frequently greatly handicapped by the too en-

thusiastic praise of over zealous friends. My first fish cultural work with the old U. S. Fish Commission was prior to 1900. To most of the younger men of that period, the brown trout, including both the Loch Leven and the Von Behr, were largely merely names of unsavory reputation along with the much maligned German Carp of the alleged mistakes of the early fathers of American fish culture. I imbibed this prejudice along with my early fish cultural training and brought it with me when I came to Montana in 1912. During my earlier years in Montana, when I occasionally heard of a Loch Leven being caught in the Yellowstone or the Madison, I paid little attention, other than to wish that it were the last remaining specimen of an undesirable and dangerous immigrant family. My conversion to an appreciation of the outstanding merits of the Loch Leven for our debatable waters although of recent date is complete.

At this time therefore, I want it distinctly understood that I *do not* advocate the indiscriminate introduction of the Loch Leven into all waters. On the contrary, in our Continental Divide region, I am strongly urging the retention of *all* our choicest waters, particularly those located above impassable falls for the use of our native redthroat trout and possibly also of our Montana grayling. I am also advocating the continuous planting of the rainbow and the brook trout in our other desirable waters wherein these most excellent varieties are now well established and thriving.

But for our third class of waters,—waters which at one time produced large harvests of the native redthroat trout and grayling, possibly later of either brook trout or rainbow, but which in these more recent years, owing to their changed character, induced undoubtedly through deforestation and pollution, no longer furnish attractive pastures for these varieties,—for our waters of this character—and may I add, for your waters of this character—I am ardently and unhesitatingly advocating the introduction of the Loch Leven trout in increasingly large numbers, numbers limited only by the size of your waters and your ability to secure the proper fish.

During these past two years, the Bureau of Fisheries has co-operated with the Montana Fish & Game Department in planting millions of Loch Leven trout in Canyon, Holter and Hauser Lakes, tremendous power reservoirs created in the Missouri River in the vicinity of Helena, and in the river below these dams and extending on down to Great Falls. This area had already been taken over in a small measure by the Loch Leven in his search for lower and larger waters. It is

a peculiarly gratifying fact, and one which adds greatly to the value of the Loch Leven for filling in these debatable areas, that he appears to have little or no desire to seek out and possess the smaller, clearer and colder mountain tributaries, but prefers to remain in the larger lower waters.

In the same breath in which I am presenting the proven adaptability of the Loch Leven for our large area of still debatable water, I am still more strongly urging you to wage a yet more valiant and intelligent, and possibly unending struggle against the evils of deforestation and pollution. But do not blindly fail to recognize a friend and ally, and refuse to accept the co-operation of friend Scotty in your efforts to secure a harvest from these slightly polluted waters.

For years in one of our neighboring states, hundreds of thousands of rainbow and brook trout and millions of native redthroat trout have been hatched and liberated in her streams. Yet during these years an increasing proportion of the catch of anglers has been of the brown trout, which throughout these same years had been largely ignored by the fish culturist.

Happily these conditions are now rapidly changing. The long time prejudice is giving way to an appreciation of the fact that the brown trout is much better adapted to the present day conditions existing in many South Dakota waters than are our native American varieties. The fish culturist is now propagating increasing numbers of the brown trout, and expending, I will not say wasting, less time and money with varieties which have been proven of less value, through being less adaptable to present day conditions.

To the best of my present information the brown trout was introduced into this region in very small numbers in the years 1889 and 1890, and solely into the waters of Yellowstone Park. Under the date of March 31, 1915, Colonel L. M. Brett, then superintendent of the park advised our then Commissioner of Fisheries, Dr. Hugh M. Smith, that while there was no official record yet it was a fact, that Loch Leven trout were planted in the Gardiner River, through some error, in 1889 or 1890, and that they were then found therein in great abundance. From the Gardiner, they worked down into the larger waters of the Yellowstone river.

These same records show that the Loch Leven were introduced into the Madison River and tributaries in 1889 and the Von Behr in Nez Perce Creek in 1890. By 1915 they were abundant in those waters. From this small introductory plant came the present tremendous numbers found in the lower

Madison where we secured our harvest of twelve million eggs last fall.

In 1890 the Loch Leven were also planted in Shoshone Creek and in Shoshone and Lewis Lakes, whence they have made their way down into Idaho waters through the Lewis and Snake Rivers.

Here then in the comparatively limited confines of Yellowstone Park, in the years 1889 and 1890, we have the inception of an epic drama wherein a small band of hardy Scottish adventurers have taken permanent possession of a great empire. These small initial plants would have been negligible, were it not for Scotty's dominant traits of virility, vigor, persistence and fecundity, coupled with the fact that here in Montana, Wyoming and Idaho waters, awaiting his advent, were conditions and areas much to his liking in the *abandoned homesteads* of our native redthroat trout and grayling. Here "Scotty" has long since *filed his claim*. Here he is and here will he remain "while grass grows and waters continue to flow." Paradoxical as it may sound, here in this new land of his adoption, "Scotty" has staged a phenomenal *come-back*. It is all the more spectacular since it was so thoroughly unexpected and unheralded.

His come-back has been absolutely without the assistance of the fish culturist, I might say, in fact, that it has been in spite of the combined opposition of the fish culturist and angler, and due solely to his splendidly adaptable inherent characteristics. He is canny and persistent like his human prototype. Where "Scotty Loch Leven" once spreads his fins, those waters are his for all time.

What is his true position in our present day fish cultural and angling economy? What are you going to do with "Scotty"? Are you going to continue to attempt to ignore his many admirable qualities? His proven adaptability to our present large and growing area of debatable waters? Will you longer harbor unwarranted prejudice, or will you now recognize his many excellent qualities; vigor, virility, rapidity of growth and freedom from disease, combined with his fecundity and thankfully accept him as an ally in your battle to preserve the fishing of our many extensive and still valuable waters which have been somewhat deteriorated through necessary contact with our twentieth century civilization, so that they no longer afford a congenial home for our aristocratic native trouts and graylings? "Scotty" has come back. He is here to stay. *What are you going to do with him?*

Discussion.

MR. CULLER: Would you advocate the planting of Loch Leven in the Firehole River of the Upper Madison, Shoshone and Duck Lake?

MR. THOMPSON: Absolutely not. That was covered in my paper. I tried to bring those facts out very clearly. He was not planted in the proper place; he should not have been planted in the upper waters in the Yellowstone Park. He should have been planted in the lower waters. But he was planted there; he was ignored all these years out in this northwestern country. So far as I know, nothing was done with him until 1923, but he has spread all over the country. He has come into his own in the lower stretches of the river, and he is there to stay.

MR. CULLER: Mr. Thompson is willing to admit it was a mistake to plant Loch Leven in the mountainous regions.

MR. THOMPSON: I have already done so, as plainly as I know how.

MR. TITCOMB: Give an answer, yes or no.

MR. THOMPSON: Yes.

MR. CULLER: Then is it not a fact that the Loch Leven has practically exterminated native trout and grayling in the Madison River?

MR. THOMPSON: Yes.

MR. CULLER: And almost the same in the Madison River at Meadow Creek?

MR. THOMPSON: Largely.

MR. BRUNSON: I think the Loch Leven is a splendid fish for warm water that native cutthroat or grayling will not thrive in, but I do not think it should ever be planted in any waters in which the native fishes will thrive. We have a splendid stream in the western watershed in Montana, the Little Blackfoot. In some way the Loch Leven have got in there, and they have taken the stream as well as the tributaries. Today if you go in there you do not catch anything but Loch Leven, although a few years back it was a wonderful stream for native. So in some streams they do ascend the small tributaries, while in others they seem to stay in the main body of water.

MR. TITCOMB: Do you find that there may be a difference in the tributary streams? For instance, my experience has been that the brown trout will not ascend the heavily shaded tributary streams but will ascend an open stream.

MR. BRUNSON: The tributaries on this Little Blackfoot are in some cases open meadow streams, while the banks of others are covered with small alders that hang over and shade them. But the Loch Leven have taken everything on the watershed that is drained by the Little Blackfoot and tributaries. The only salvation of western Montana is that the Little Blackfoot empties into the Missouri River and all the water from the Butte mines is pumped into this river, consequently the fish cannot get down to ascend the other streams.

MR. TITCOMB: It is simply a question of temperature as to which tributaries they enter.

MR. BRUNSON: Well, the water up there on the Blackfoot is so cold that when you drink it it makes your teeth ache. The Loch Leven there do not get up over eight or nine inches long. It seems to be more a question of food and bottom.

MR. LEACH: I am ready to admit that Loch Leven should not be planted in certain waters in the Yellowstone and mountain regions. I feel this way about the Loch Leven: we have in our planting program found that brook trout, rainbow trout and some other species do not thrive in certain waters. So that rather than have certain lakes and streams stocked only to an efficiency of say 25 to 40 per cent, why not put in a fish that will stock it 75 to 100 per cent? I do not think we have a right to say to the average angler of the country what kind of fish he is going to fish. In the Yellowstone region the black spotted trout spawn during the tourist season, from the first of June till the latter part of July, and after that they are not in the best condition to catch. Yellowstone Lake should be stocked with black spotted trout, and I think it might be well in some of the other lakes and streams to stock with black spotted. But at the same time we ought to give the tourist a chance to catch fish, especially when he comes to Glacier Park, Rocky Mountain Park, Yellowstone Park and others, and to catch good fish. If the average tourist who goes out there catches a large Loch Leven, a large brook trout or a large rainbow trout, he is pretty well satisfied. Brook trout and rainbow trout, are introduced species in the Rocky Mountain region, and I do not see why in our waters, if they meet our expectations so far as spawning is concerned, we should not resort to stocking with Loch Leven. In supplying introduced fishes to certain waters we are always glad to respect the wishes of the state. If the state objects, as Montana did a few years ago, to the stocking of any more of their waters with Loch Leven trout, we are only too glad to conform with their wishes. We do not want to impose upon any state in any way. There is a great demand for the Loch Leven trout for other waters throughout the United States. During the last few years, fish commissioners from all over the country have been making demands on us for Loch Leven to stock waters which have not successfully responded to the stocking of other fish.

During this discussion when Mr. Thompson was talking, I felt that I would have to ask him to quit boosting the Loch Leven trout, because requests have been coming to me for millions of Loch Leven eggs, and if he keeps on boosting them we shall never be able to supply the demand. But I do believe that in the eastern and northern states there are waters in which the Loch Leven will thrive and give a very good account of themselves, and I believe there are other waters that should be stocked with brook and rainbow. But certainly a careful study must be made of

the waters to be stocked. I feel that most of the commissions in the different states know their waters better than the Bureau of Fisheries does, and that introduction should be through the states more than through the Bureau of Fisheries. To assist the states we have been giving them 75,000 Loch Leven eggs for the purpose of establishing brood stock and getting started. We do not feel we can give them more than that unless some arrangement is made for exchange of eggs, because it costs the Bureau a good deal to operate in the Madison Valley. We are always willing to make an exchange of eggs with the states; brook trout and rainbow eggs may be exchanged for Loch Leven to supply the needs in other sections of the country. We are always willing to abide by your decision with regard to the introduced species and to help you out in every way possible.

MR. TITCOMB: We have been talking all the time about Loch Leven trout. When I first assumed charge of the Division of Fish Culture in Washington in 1902, my predecessor made the statement that the Bureau of Fisheries had discontinued the propagation of brown trout because they considered it a very predacious fish, and were propagating the Loch Leven trout, which they considered a very gentle animal. At that time the fish propagated was called the Loch Leven. The United States Commission, as it used to be, I think first imported the brown trout of Germany. What I want to get at now is whether Mr. Leach or anyone here can say what is the difference between the so-called Von Behr of Germany and the English and Scotch trout, and whether they know that the fish they are now propagating so extensively is distinct in species from the German brown trout.

MR. LEACH: The Scotch trout is something like Scotch whiskey; it has been so mixed that it is pretty hard to identify it. Of course we all know that the Von Behr trout, a brown trout, was brought over from Germany and introduced in certain waters in the eastern part of the United States in the early days of the Fish Commission. Loch Leven eggs were also brought over from Scotland and introduced in eastern waters, and we feel that these species have been pretty well mixed and mingled. In the eastern part of the United States everybody refers to it as the brown trout; in the western section it is known as the Loch Leven trout. Whether or not there is any difference, and whether we have the true Loch Leven in the west and the true brown trout in the east I do not know; but I doubt it; I think they are mixed. Certain fish culturists who are propagating brown trout and Loch Leven trout in the east have admitted to me that if I were to take a brown trout out of one of their ponds and a Loch Leven out of another and bring them to them and ask which was which, they would not be able to tell. When it comes down to that point I doubt if there is any difference. I think the environments have changed the fish so that it is pretty hard to distinguish one from the other. For instance, take steelhead eggs

from the Pacific coast, bring them east, set them down in Neosho and leave them there several years, and you will find it very difficult to distinguish the steelheads from the rainbows which they are producing at that station. The same is true with steelhead eggs sent up to Vermont and in that section. So I doubt if anybody is in a position to say whether we have true Loch Levens in the west and true brown trout in the east or not.

MR. TITCOMB: I do not doubt that you can tell the difference between Scotch and rye. Is there any difference ichthyologically between these two fish—such a difference as there would be between Scotch and rye, or are they just two branches of the same thing?

MR. LEACH: Mr. Titcomb gives me credit for being an epicure in the matter of Scotch and rye, but not when it comes down to fish. Well, I doubt if there is. I think that the Loch Leven and the brown trout are very closely allied to our brook trout and that the environment makes a difference, although I have talked to men who claimed to be well up in fish culture and who contended that in the Loch Leven trout there is a different system of configuration in the spots than there is in the brown trout, and they claim they can tell the difference. I believe Professor Zarrett claims he can tell by the markings the difference between the brown trout and the Loch Leven. He seemed to think so last year when he was over on the Madison, but I have my doubts. I think if a similar fish was taken from some other section of the country and Professor Zarrett was called in to diagnose the case he would fall down on it.

MR. TITCOMB: Yet you admit that the rainbow and the steelhead are two different species, do you not?

MR. LEACH: Well, I do, under certain conditions. The steelhead, of course, is supposed to be a sea run trout and the rainbow is supposed to be one that remains in the rivers. When you put them under the same conditions you find very little difference between one and the other. I doubt if anyone could go to Lake Superior at Duluth and fish steelheads and rainbows and tell the difference between them, because in some cases the greenish back of the steelhead has changed to a black, and you find rainbows in which the dark blue back has changed to greenish, while at the same time they are devoid of the rainbow's stripe down the sides. So it is difficult to distinguish between these species when you hold them under similar environments.

MR. TITCOMB: I just want to direct attention to the fact that the society paid Dr. Kendall a prize of \$100 for working out the difference between rainbow and steelhead. He decided that they were two different species.

MR. THOMPSON: I would like to add a word to that, and I think it will help Mr. Titcomb out in telling the difference between the steelhead and the rainbow.

MR. BENGARD: I have had some experience with the brown trout in New Mexico. I am located on the Pecos River. Somewhere along in 1905 a small quantity of brown trout or Loch Leven, perhaps 1,500 in all—they were known in that country as German Brown—were introduced into a nursery pond on the bank of the Pecos River. They multiplied very rapidly in this small pond of less than a quarter of an acre. In four or five years this pond washed out and we now have our hatchery at that very same place. At that time the Pecos River was still stocked with black spotted cutthroat trout, the only variety in the river at that time. To my certain knowledge, during the last eight or ten years there have been several hundred thousand rainbows and other trout fry and fingerlings planted in the Pecos River, but today, and it has been so for a number of years, it is an undisputed fact that out of every twenty fish that are taken from the Pecos River over a distance of forty miles you can bet your bottom dollar that nineteen of them will be German Brown. Now you can take this just as you like, either in favor of Scotty, as Mr. Thompson calls him, or against him. But I am in favor of the German Brown. He is a hardier fish and will not succumb to the ailments which play havoc with the other fish. Therefore I have been trying to buy brown eggs for the last two years, but without success. Mr. Thompson and Mr. Ainsworth are two enthusiasts, but I am in favor of the German Brown.

MR. HAYFORD: In 1916 we got our first Loch Leven eggs from California. In working the eastern brown in our plant we had difficulty when we transferred them from the hatchery to the ponds; they would get into the corners and we could not get them up. As long as they were in troughs in the buildings there was no difficulty. So I got 100,000 Loch Leven eggs from California and ran a check with the eastern browns as against them. The difference from the fish cultural point of view is that the Loch Leven fry would never rise to the surface as the brook trout did and we had no difficulty in feeding them. But the Loch Leven did not do as well after they reached a year and a half or two years old as the brown did. So Dr. Embury and myself discussed the matter and we decided that we would cross the so-called Loch Leven with the eastern brown, with the result that we got our first check of any importance in May, 1924. In the first year of the browns we lost seven per cent to the eyed egg stage. In 1922 it was nine per cent. In 1924, when I could get a decent check, the loss of this cross from the green to the eyed stage was only two per cent. We had the strain of Loch Leven run against the mixed strain of the so-called western Loch Leven and eastern brown, and the Loch Leven had beaten the brown up to two years by about two inches in length but has not been standing up as well as the cross in our ponds. The loss is greater in the Loch Leven, but we think we are going to eliminate that. We are satisfied it is only a question of the elimination of the weakest.

CO-OPERATIVE FISH CULTURE.

BY GLEN C. LEACH.

Chief of the Division of Fish Culture, U. S. Bureau of Fisheries.

The difficulties encountered at the present time by those who are charged with the maintenance of the supply of food fishes in the public waters of the United States are making it increasingly evident that much closer relations than have heretofore existed between the Bureau of Fisheries and the various State fishery departments must be assumed if any great measure of success is to be attained in the work. It is clearly evident that the demands for fish for stocking purposes are growing at a rapid rate. Among the many causes for this condition may be mentioned the rapidly extending use of the automobile by fishing parties and the facility with which distant and heretofore inaccessible waters may be reached by means of it. There are numerous streams in the west, practically untouched a few years ago, which at the present time constitute camping sites for tourist fishermen, many of them transcontinental. Other leading factors in the lessening of the fish supply in public waters are the rapidly disappearing forests and the continued encroachment on heretofore idle lands for agricultural purposes. The increase in the amount of land put under cultivation naturally causes a corresponding decrease in the number of streams and in waters formerly suitable for trout, and for the warm-water fishes also.

One of the most destructive effects of deforestation is seen in the degeneration of adjacent fish-cultural waters. Streams and lakes which at one time were surrounded by forests and comprised an ideal environment for trout have, since the denudation of the land, passed through various transitory stages until at present they are hardly fit for carp. As a matter of fact good trout waters in the eastern sections of the United States are becoming scarce. The clearing of the forests has diminished the flow of many springs and the increased amount of sunlight admitted has raised the summer temperature of the waters to a point where trout can not thrive. After the waters have been inhabited by bass and allied species for a few years their food supply falls off and the considerable amount of soil washed into the waters from near-by cultivated fields eventually renders them unsuitable even for the so-called warm-water species of fish.

In order to cope with the changing conditions brought about by the activities and the destructive tendencies of man it is considered necessary to adopt new methods in the work

of producing fish for stocking purposes. In this respect many of the States have already taken the initiative. I do not mean to say that the State people have been broader minded or more far sighted than others but they have found it easier to secure through their legislatures adequate funds for conducting their work to the best advantage. The stocking of interior waters with fish life is a matter in which the public and the legislatures of the States are more nearly interested than are the National law-makers. There has been no noteworthy addition to the Bureau's fish-cultural equipment for a number of years and no modern Federal hatcheries have been established. The Bureau's officials have repeatedly called the attention of the powers that be to the pressing necessity for enlarged funds with the view of increasing the efficiency of the fish-cultural work. However, it appears to be a much simpler matter for many of the States than for the Bureau to secure recognition of the importance of maintaining the fisheries, since they have been able to increase their fish-cultural facilities to the point where they are now producing large fingerling fish for distribution.

The Bureau's hatcheries were constructed many years ago when the importance of producing fingerling fish for stocking purposes was not so apparent as now. This fact becomes evident when the stocking program pursued by the Bureau of Fisheries a number of years ago is carefully studied. Originally the rainbow trout was not found east of the Rocky Mountains. The Federal fisheries authorities shipped the eggs to eastern hatcheries and distributed the resulting fry in practically all streams where the conditions were suitable. Judging from the results most of these plants have been very successful and at the present time several of the States as well as the Bureau, are taking rainbow eggs by the million from wild fish secured in waters east of the Rockies. The same may be said with regard to the Loch Leven and brown trouts, which were introduced in most of our streams many years ago.

The changing conditions of the streams are making it necessary to introduce larger fish than formerly and the State authorities have taken advantage of the situation to secure from their legislatures more adequate funds for extending their hatching facilities and for rearing small fish to the fingerling or yearling stage before releasing them. It is quite apparent that the food supply of the streams is not sufficient and the protection afforded them is not adequate for the maintenance of small fry. As many of the Federal stations are now surrounded by town sites and improved lands,

it is practically impossible for the Bureau to extend its fish-cultural operations or to increase the holding capacity of its established stations. Many of the States are also in a better position than the Bureau to disseminate the product of their hatcheries. The output from practically all of the Bureau's hatcheries must be divided among the waters of several adjacent States. The States, on the other hand, maintain several hatcheries located at convenient points in a number of instances, which permits of an easy distribution of their output at a comparatively small cost.

It would be very difficult for the Bureau to hold several hundred thousand young trout until October for distribution and the cost of such a procedure would make it prohibitive. In their work of producing large fingerlings the States can enlist the services of game and fish organizations and in some cases of individuals, many of whom apply for and receive their fish at the State hatcheries.

In view of the limited holding capacities at practically all of the Federal fisheries stations the Bureau recently undertook to secure the cooperative assistance of fish and game organizations and individuals in the work of rearing for fall distribution the small trout ordinarily put out from its hatcheries in the spring of the year. The increasing demands for bass and other warm-water fishes will be met by requesting the organizations to set aside a few of their ponds for the propagation of such species. An appeal for this assistance was made by Secretary Hoover in January, 1925, and many responses from various sections of the country were received. In the upper Mississippi Valley the Izaak Walton League proffered the use of ponds for work with the warm-water fishes and an effort was made to establish rearing ponds for trout in the vicinity of Winona, Minn. In the East a number of organizations in Pennsylvania have taken an active part in establishing nursery ponds and rearing small fish. In all such cases it is the understanding that 50 per cent of the fish produced shall be utilized in stocking local waters, and a recent inspection by Bureau officials has brought out the fact that it is entirely feasible to rear fish under such a plan.

To accustom them to feeding most of the fish are held until June in troughs 16 feet long, 18 to 24 inches wide and 8 inches deep inside, with a tight cover over the upper half of the top and wire screening over the remainder. In such a trough, with a spring water supply of 15 to 20 gallons per minute, 10,000 trout can be held until the middle of June, at which

time they are transferred to rearing ponds and held until October, when they are distributed.

With cooperative work of this nature in view the Central Pennsylvania Fish and Game Protective Association, of Harrisburg, Penna., recently purchased 16 acres of land and constructed thereon two half-acre ponds, thus providing sufficient rearing space for 200,000 fish, for distribution as fingerlings in the fall months. Fifty per cent of the fingerlings reared in this nursery would be used by the Bureau for planting in local waters.

Under the old system this number of fish, constituting a carload, would be transferred from the White Sulphur Springs (W. Va.) station during the spring and planted in streams in Pennsylvania as fingerlings No. 1. The results of placing very small fish in the streams are extremely doubtful. On the other hand, under the cooperative arrangement recently adopted the 200 cans of small fish will be held and fed until they attain a length of $3\frac{1}{2}$ to $4\frac{1}{2}$ inches at which time 2,000 cans will be required to transport them to the waters for which they are destined. Pennsylvania and several of the Eastern States have found that to attain success in maintaining fish life in their streams comparatively large fingerlings must be planted.

It can therefore be seen that the proposed cooperation will not only be of great benefit to the Bureau but it will also aid the States materially in keeping their waters stocked.

Cooperative work with clubs and organizations along the lines suggested can only be undertaken in cases where there is a caretaker who can devote part of his time in attending to the fish. In every instance the delivery of fish will be made by one of the Bureau's experienced messengers who will instruct the keeper as to the proper manner of handling small fish. Further, frequent inspections will be made by a trained fish culturist of the Bureau so that the office may be kept in close touch with the different projects.

The Bureau has continued to cooperate with the various States in all branches of fish-cultural activity. In many instances it has exchanged eggs with them; in other cases the States have incubated eggs of various species supplied from the Federal hatcheries and distributed the product to the Bureau's applicants living near the State hatcheries. The States have aided the Bureau in the collection of eggs in certain fields, and the Bureau has extended to the States the privilege of purchasing trout eggs and incubating them in the Federal hatcheries.

It is believed that still closer relations between the States and the Bureau will mean a material conservation of funds for each organization and at the same time result in greater efficiency in the stocking of public waters. If some plan could be devised whereby the Bureau could submit to the State officers all applications it receives from applicants within the State's jurisdiction it is felt that many duplications in the work of stocking waters might be avoided. Such a plan is now in force with respect to applicants for the non-indigenous fishes but to extend it to all applications received would necessarily entail considerable work on the part of the State in handling them.

The Bureau of Fisheries is very desirous of aiding the States in their fish-cultural work in every possible way but it is reluctant to ask them to assume any of its obligations. The Bureau appreciates fully the work the States are accomplishing and it will not only loan the services of the force under its direction whenever this can be done to advantage but it will go as far as the law will permit in furthering any projects that promise to result in increasing the production of fish.

Discussion.

MR. ADAMS: I would like to say this in respect to Mr. Leach's statement, viewing it from the standpoint of one man who has charge of this work in one of the states. It has always been a mystery to me how the United States Bureau of Fisheries and the Bureau of Biological Survey could do as much work throughout the United States as they are doing on the amount of appropriation that is made available to them. When we stop to consider the amounts that are available in the several states with which to carry on the work, we realize that if it were not for the great ingenuity of the men in charge of the various stations of the United States Bureau of Fisheries throughout the country and the high quality of the work carried out in these divisions, certainly we could never get the results we are getting today. I have the feeling that there is a lack of team work here, and I do not discuss the matter with the idea of saying anything in any sense derogatory of the work of the Bureau of Fisheries. But it can be analyzed something along these lines: We who have charge of this work in the several states are very largely out of touch with what the United States Bureau of Fisheries is doing. For example, within the last two weeks I had a notice from one of the fish and game clubs in our state that that club had planted a very fine shipment of rainbow trout that had been received from the United States Bureau of Fisheries. Now under our law it is necessary for any individual or club to receive authorization

from our division to plant any species of fish or game, and the same applies to birds and quadrupeds that come in from outside the Commonwealth. The idea, of course, is obvious: that we may be able to ascertain whether the fish, birds or animals proposed to be brought in from a given locality are suitable for our areas, and in order that we may have some supervision as to the question of disease and so on.

As the matter stands today, shipments of fish are constantly coming into Massachusetts from the United States Bureau of Fisheries of which we have no record whatever. A great many of our individuals and clubs, not with any idea of violating our state laws, but rather through lack of knowledge, have these shipments coming in, so that when a year's distribution work is completed, while we have a very accurate record of what we have done in our own state activity we have no adequate or complete record of the contributions from the United States Bureau of Fisheries, which amounts to quite a good deal in the course of the year. My feeling is that the United States Bureau of Fisheries could probably function in this respect to the greatest advantage if they were to proceed in collaboration with the State Departments having charge of the work.

Mr. Leach has certainly adopted a good plan of putting fish and game clubs in a given state to work. As an illustration we have three or four such rearing stations in operation in the state of Massachusetts today. These different clubs, under the supervision of one of our fish hatchery superintendents, select a site and then we help them to keep right in regard to the fish they get. The service is entirely voluntary on their part. They get a little plant into shape and we supply them with the fish. We impress them with the fact that if they get into a jam anywhere along the line one of our superintendents will be immediately made available to consult with them as to what the trouble is and what the remedies may be. In this way we are encouraging these men to help themselves. We permit them to distribute locally all of the fish that they produce in that rearing station. We aim to give them—and this is confined for the time being to brook trout—fish that have been fed anywhere from thirty to forty-five days, or which we have had under our control until they have got by the greatest period of loss. We are doing the same thing with these clubs in the matter of pheasants. We are up against the same proposition that Mr. Leach describes, namely, that we have producing plants in which we can start off a large stock of wild life but we have not the facilities for rearing them to the suitable ages.

I believe that we are all agreed that the time has come when we have got to put into our streams brook trout that are big enough to be caught when they are put in. This is not true, of course, of some of the big western states where the question arises of transporting fish over long distances, and perhaps to that extent I am thinking of conditions east

of the Mississippi River. Now the same thing is true in the matter of pheasants. For example, a number of these clubs take pheasants that heretofore we have been liberating about the size of Hungarian partridge, and they have agreed to take care of them, carry them over the winter and liberate them the following spring as adult birds. If a rearing station take a batch of pheasants to raise and lose every one of them, it may be one of the best things that can happen in that locality in a given year, because it begins to make those clubs in a succeeding year appreciate the stock when they get it from some state agency. You will never convince them that the raising of fish and the raising of birds is a difficult proposition until they have had a little local experience of that kind on their own part. When they do that they will begin to understand what the fish superintendents and bird superintendents are up against. In many cases they accept this stuff as a matter of course and they believe that the production of it is an easy thing; they do not realize how the superintendents of these hatcheries have sweat blood to produce this stuff successfully. They do not know anything about the heartaches and heartbreaks, almost, that come to these men in their efforts to do efficient work. Now if we can visualize it through these local institutions; if we can give them the work to do themselves and then help them to get straightened out when they are knocked flat, we shall have done something of educational value that is bound to produce great results in the future.

Referring to this question of team work between the United States Bureau and the states, it strikes me that we could work it out along the lines Mr. Leach has in mind. For example, suppose some club in Pennsylvania, Massachusetts or Montana wishes to do this thing. If the Commissioner or Mr. Leach were to write to the State Department and say, "Here; maybe you fellows don't know about this, but the XYZ Club have ambitions to start a little rearing station and they want us to supply them with the necessary material. How are you folks situated in your state? You know how we are fixed. We are trying to do a big job on a shoestring, and we are simply making the inquiry in the first instance. Can you fellows take the load off our shoulders? Can you supply this local station out of your own stock?" Now, I surmise that in a good many instances the Bureau would find that the state government could help out substantially if not entirely. And when it comes to the question of distributing the fish in a given state I am inclined to think that if the Bureau, with its limited office equipment, could in some way or other submit to the heads of this work in the different states a list of applications that they had received from a given state for stock in a given year, so that the State Department could look it all over, we would be in a position to say to the Bureau: "We have gone down through your list and we find that we have already made adequate provision to take care of a certain number of people named on this list." I know that is the

condition in our state and I believe it is the condition in a good many states. Then there may be individuals here and there who for some reason or other have more confidence in the Bureau than they have in their own state administration, and they in the first instance go to the Federal Government direct, whereas if we had the opportunity to know who they were and to get in touch with them we could begin to take the load off the Bureau.

The primary object I have in mind is to be helpful to the Bureau: that each state endeavor to relieve them of the enormous pressure they are working under with limited funds, limited equipment and limited help. It may turn out, as I know is the case in some instances, that some ambitious club is trying to beat the game. By that I mean that they will ask the State Department for a certain number of brook trout fingerlings. From our knowledge of the region in which these fingerlings are proposed to be distributed we know that we have already planned to give the people in that locality all the fish that the waters in that area can properly absorb in a given year. We know that if the United States Bureau of Fisheries sends additional shipments into that area the result will be to overstock certain streams. Now that is no reflection on the Bureau, because, being far removed from the area in question they have not the opportunity to know the exact conditions. But we have, or certainly we ought to if we are on the job. Or it may be that we are working at cross purposes. It may be that the people in a certain locality, acting in good faith but without the proper fish cultural knowledge of the capacity of the waters in their district, propose to overload their streams, whereas the stock which they request from the Bureau could be used to much greater advantage in some other section of the country. I simply throw out the suggestion that we who have charge of the work in the various states try to see to what extent we can help take this load off the Bureau. I suggest that so far as practicable, in the greatest spirit of friendliness, we say to the Bureau that we certainly would like to have them take us a little more into camp and work a little more closely with us. In other words I believe the average man in charge of this work in any state never resents having a job shifted over to him by any of the federal agencies. We realize the enormous ground the Bureau has to cover. I am sure I can say on behalf of every man in this room and on behalf of every state that we marvel at times at the work the Bureau does considering the handicaps under which it labors. We sincerely hope that in the future the Bureau will find it possible to put us to work just as they plan to put clubs to work. Give us a job, and let us try to have the greatest possible teamwork, which can only result in benefit to all concerned.

MR. TITCOMB: We all appreciate the work of the Bureau, and we appreciate their difficulties. The conflict in policy between the state authorities and the Federal Government is difficult to adjust. Most of

the states stock only waters which are open to the public. The Federal Bureau stocks private waters. I imagine the clubs you refer to are largely private clubs which want to improve their own private fishing, and the public are taxed when the Federal Government does anything for them. Now in attempting to cooperate in the matter of the distribution of fish, we in Connecticut, for instance, would handle certain applications to advantage and save the Federal Government the trouble of shipping perch half way across the continent, perhaps, to supply a United States senator or one of his influential friends. But when it turns out, on our seeking to co-operate, that these few cans of perch which are coming in from the Illinois River or some other place are going into a private pond, then we are stopped; we cannot do anything for the Bureau unless there is some possible solution of it through an exchange. But the minute the anglers of the state see a state fish can going to a senator's fishpond, or to that of one of his influential friends, there is going to be a howl. That is one of the problems that I should like to see solved. My way of solving it would be to cut out all the stocking of private waters by any state or federal government and have it done at the expense of the clubs. Let them pay for them.

I think the idea of getting these clubs to raise the fish is a mighty good thing. I have done a good deal of that work. When I was with the Federal Government—the field stations have been in operation now for thirty years—part of the progeny returned to that water went to keep up the field station. Take for instance the trout. The Bureau of Fisheries has a station in Massachusetts which cannot produce anything but fry. An enterprising club in Connecticut—I am not now referring to a private club—applied to us for some fish. Well, we believe in stocking our waters to the limit of their productive capacity. Then they wrote the Bureau of Fisheries and they got a lot of these other fry from Hartsville. We sent out a little later some fingerlings, three, four and five inches long, for the same waters, and our fish are much longer than the fish sent from Hartsville. That does not work to the best advantage if you are going to consider the economic as well as the general aspect of the whole subject.

Mr. Adams spoke of co-operation in respect to the species foreign to the state, non-indigenous species. It has been customary for the Bureau of Fisheries to submit to our Commission applications for species not now inhabiting the waters for which application is made. In Connecticut we do not have much trouble as to the putting of bass, for instance, in trout waters. But some fellow may want to put brown trout in waters suitable to brook trout, and when I refuse his request he calls on the Bureau of Fisheries. In such a case it is essential that I have the co-operation of the Bureau and notice from the Bureau as to the shipping of brown trout into any of our waters. We should resent their sending brown trout to stock any waters not now inhabited by them unless we

had first passed on the application. If Mr. Leach can work out some plan whereby we can co-operate and save his shipping cans of fish half-way across the continent when we have the same stuff right there close by, we are ready to go in with him. Now the Bureau of Fisheries is not properly supported. They do not have the proper appropriation. The reason they are giving fish to private clubs and backing them is because the men in these clubs are successful business men and they are depending on them to help them get their appropriation. It should be the work of every state commission to help them; they should not have to depend on the individual who is going to get a few cans of fish for nothing. It should come about some day that that will be done away with, just as the distribution of seeds has been done away with, and let the whole country stand on a par in regard to that sort of thing.

While I have usually got what I went after with the Bureau of Fisheries, I may say that having been in the inside I know the method of procedure fairly well. But I have not taken advantage of opportunities to use influence when I might. I have sometimes noticed in the reports of the Federal Bureau that after I had tried to get a certain amount of fish and was invited to co-operate by helping to operate field stations, some club in the state was able to get the same stuff for nothing. It is up to every one of us here to uphold the Commission in its efforts to try to straighten these matters out so that the State Commission can have the handling of this product from the Federal Government rather than the private clubs. That has been my view ever since I was in Washington.

MR. AVERY: Before Mr. Leach responds to these various suggestions that have been put up to him, I want to put up just one more so that he can handle them all at once. I do not want to precipitate any extended discussion of a long controversy which has been going on for so many years, namely, the question of relative value of fry and fingerlings. But Mr. Leach in his discussion emphasized what is apparently a fact, namely, that many of the trout streams are in such condition with respect to food that No. 1 fry will not survive in them whereas the advanced fingerlings and the larger fish will. Mr. Adams emphasizes that all the more by saying that in Massachusetts they are going so far as to advocate the planting of fish that are large enough to catch. Now in order to have this matter reduced to some system, to a point where the fish culturists, the state commissions and the Bureau of Fisheries may know what they are doing, there should be some knowledge of the condition of each one of these streams before it is planted. What I would ask Mr. Leach, and any others who are familiar with the processes of finding out these things, is just what is being done to determine how many fish, and of what size, can be planted successfully in a given stream. Are surveys being carried on to determine what amount of food is in the stream and what sized fish it will support, or are they merely depend-

ing on the results of previous plantings as to whether there has been any development of fish or improving of fishing?

DR. RISER: Speaking of planting fingerlings and fish ready to catch, I have advocated for some time that fry should never be put into a stream without the stream being screened. I have had fifteen year's experience in commercial trout growing. When I put little fish into my ponds out of the trough, if there is any chance for them to escape they will be over the whole place in less than two hours. If you put these little fish at the head of a stream without screening the stream, they are going to be up and down, getting into the swift waters, and not one in a hundred will escape the big fish. If he has a chance to get into a place where there is an eddy there is sure to be a big fish there to pick him up. It is not a great expense to screen that stream, if only for one week so that the little fellows can adapt themselves to the surroundings, after which they will stay there. It does not take long to deplete a stream if you do not protect the little fellows.

MR. LEACH: In answer to Mr. Adams I wish to say that the Bureau of Fisheries is always willing to cooperate with the States. However we are obliged to deal with U. S. Senators and Representatives in Congress whose chief interest in the matter is on the side of their constituents. Were a State to advise the Bureau that it would undertake to supply one of its applicants and for some reason it failed to do so or the applicant was not given the full number of fish he expected he would at once appeal to his Congressman to ascertain why the Bureau had not supplied him. We of course realize that a man is apt to apply both to his State authorities and to the Bureau for fish for the same body of water, but when a member of Congress is interested in the case, and frequently it is a special case, we find it difficult to impress upon him the justice of reducing the assignment or permitting the State to fill the application.

Some years ago the Bureau entered into what seemed a very satisfactory agreement with a certain State. Under the terms of the agreement the State was to supply all applicants for fish north of a designated line while the Bureau undertook to fill all requests emanating south of that line. The Bureau's part of the contract was carried out and after the close of the distribution season, when the stock of fish at the hatchery was exhausted, the State officials returned about 300 of the Bureau's applications by express collect with the information that they could not fill them. This naturally disarranged our plans and we were kept busy the remainder of the season explaining why the applications were not filled. In other cases we have found the States very generous and they have assisted us materially in distributing fish to applicants within their boundaries.

All assignments on applications for trout are made on the first of April. Therefore, in order to insure prompt delivery of fish, it is essen-

tial that an application be submitted well in advance of that time, since it must be referred to the State authorities for indorsement before it can be acted on. The same holds true with reference to black bass and other warm-water species the assignments of which are made on the first of July.

Mr. Adams can not dwell too strongly upon the mistake of introducing more fish into waters than their natural food supply will support. I think it is the policy of most of the States, especially the Eastern States, to make a careful survey of their streams to determine to what extent they need stocking and the species of fish that should be introduced. It naturally follows that the States have a better knowledge of the waters within their boundaries than has the Bureau and are in a better position to decide what action should be taken in the matter of stocking them with fish life.

The Bureau would be pleased if some scheme could be devised whereby it could turn over eggs of a certain species of fish to be incubated in the State hatcheries with the assurance that the product would be used by the State in supplying the Bureau's applicants in that region. If such an arrangement could be effected it is believed there would be no further trouble regarding the introduction of non-indigenous and unsuitable species of fish into State waters. I am speaking more particularly with regard to the pike perch. The Bureau has always hesitated about asking a State to incubate the eggs and distribute the fry to applicants living therein. It has felt that it was under obligations to handle its own applications without seeking State assistance. However, I am pleased to note that both speakers are apparently of the opinion that the States should cooperate in such work.

Answering Mr. Avery's inquiry I wish to say that when an individual applies for fish he is required to give a fairly accurate description of the waters he wishes to stock, and from the information contained in his application we must draw our conclusions as to the species of fish to assign and the number to be supplied. At the expiration of three years after the fish have been furnished a blank form asking for a report of the results of the plant is sent to the applicant. By means of this system and from the data furnished by its field employees regarding waters of which they have a personal knowledge the Bureau is able to keep a fairly accurate record of the waters for which fish have been supplied.

The number of fish that should be placed in a given stream or other body of water should be governed by local conditions, such as its size, source, tributaries, and the amount of natural food it contains. All of these are important factors and should be given careful study in each individual case to attain the best results in the planting of fish.

At the Allentown, Pennsylvania, meeting Mr. Adams presented what appeared to be a very feasible scheme for cooperative work in the production of larger fish for stocking public waters and the Bureau

decided to adopt it. Noting the commendatory terms in which Mr. Adams and others have expressed themselves with regard to the results the Bureau has attained with its limited funds, I wish to say that during the fiscal year 1926 the Bureau will operate on exactly the same amount of funds it received in 1917 but its production of fish will probably exceed the output of that year by approximately 30 per cent.

Though very inadequately compensated, the Bureau's field employees have devoted their best efforts toward increasing the Bureau's output and at practically all of our hatcheries they have succeeded. The recent readjustment act has given them some slight increase, though their compensation at the present time is less than that paid by most of the States. They have served the Bureau faithfully, however, and have contributed the difference between low salaries and the salaries that should have been paid, and to that fact we owe the success of our work. The results have been accomplished by experienced men working without regard to the eight hour law.

SYMPOSIUM ON FISH CULTURE

MR. TITCOMB, PRESIDING.

MR. TITCOMB: I am going to suggest a time limit of five minutes for speeches, which may be extended on occasion if necessary—five minutes on any one topic. I would request also that you confine yourselves closely to the particular topic under discussion.

One of the topics you are most interested in, judging from what I have heard and from the suggestions I have received, is that of fish food, and I would like to have you lead off with that subject. All I am going to say on it, for my part, is with reference to trout. I am talking about feeding not in artificial pools but in rearing plants. In our two hatcheries we are feeding beef liver almost entirely. We buy the best A grade of beef liver from a certain company which is located a short distance from our hatcheries. It is the only grade we would take; it is considered economical to buy the best. We mix some beef hearts with it. We are feeding between four and five hundred pounds of liver a week now. I will say in connection with the use of cod liver oil and yeast that we have been trying it with a few troughs under control in the way Dr. Davis suggested, and while we have not any results to report as yet in regard to it, we are interested to find that the series of troughs below the ones in which we are using cod liver oil and through which the same water flows appear to be producing the best trout we have in the hatchery. In other words, the cod liver oil from the food placed in the experimental troughs is oozing into the water in the second batch and apparently improving their condition.

SOME EXPERIMENTS IN TROUT FEEDING—

A PROGRESS REPORT.

BY H. S. DAVIS AND M. C. JAMES,

U. S. Bureau of Fisheries.

At the last meeting of this Society in Quebec we gave a brief summary of some of our experiments on the addition of substances rich in vitamins to the standard trout foods. Cod liver oil was used to supply vitamin A and dried brewer's yeast as a source of vitamin B. In addition, in a few cases, orange or tomato juice was used as a source of vitamin C. These experiments carried on during the past two summers

(1923 and 1924) with rainbow fingerlings gave remarkably uniform results and showed that the addition of small quantities of these substances to either beef heart or sheep liver resulted in a marked decrease in mortality and increased growth.

The experiments were continued at the White Sulphur Springs, W. Va., station until late in the fall of 1924, and during the present season have been renewed at the Holden, Vt., station where it is planned to conduct extended experiments dealing with various problems in trout culture.

It is our purpose at this time to supplement our report of last year with some of our later findings which may be of interest to the members of this Society.

In our former paper it was shown that a comparison of beef heart and sheep liver with the addition of cod liver oil and yeast showed a distinct advantage for the heart, oil and yeast ration during the first two or three months, but that later the liver, oil and yeast appeared to show an advantage over the heart ration. As the experiment was continued it became evident that this apparent reversal of conditions was only temporary and at the end of the season the fish fed heart, oil and yeast showed a distinct superiority, both as regards growth and mortality over those fed a ration of sheep liver, oil and yeast. No experiments have yet been made with beef liver, but we hope to try this in the near future.

Of special interest is the experiment conducted at the Wytheville, Va., station, also reported upon last year. This experiment was continued until May 1, 1925, and is the only one of the kind which has been carried on continuously for that length of time. In this experiment 4,000 rainbow fingerlings were divided into two lots of 2,000 fish each, and each lot was held in two hatchery troughs throughout the experiment. One lot, the controls, were given a straight diet of beef heart, while the other lot was fed beef heart to which 3% of cod liver oil and 4% of yeast were added. Later the amounts of oil and yeast were reduced to 1.5% and 2% respectively. From the very first there was a marked decrease in the mortality of the vitamin lot as compared with the controls and this difference in mortality was maintained up to the end of the experiment with the exception of a few weeks during the winter. There was a comparatively high mortality in both lots during the warm weather of August and September, reaching approximately 24% for each of these months in the controls. However, in the vitamin lot the mortality was only about 9% in August, and fell to 5% in September.

During the next three months the mortality gradually decreased, reaching its lowest level in December when it was only about 5% in the controls and 2% in the vitamin lot. During January and February the mortality rapidly increased and during the latter month was approximately 3% in the vitamin lot and 12% in the controls. There was a still greater increase in the mortality during March and in April it reached 34% in the controls, while it was approximately only 6% in the vitamin lot. At the end of the experiment on May 1st the vitamin lot showed a total mortality of 882, or 44%, while the controls showed a mortality of 1,656, or approximately 83%.

These results are the more striking when we consider that as a result of the heavy mortality in the controls these fish had considerably more room during most of the time than the fish in the vitamin lot which became badly crowded toward the end of the experiment. The growth in the two lots is without significance, since throughout the course of the experiment each lot received the same amount of food regardless of the number of fish.

One of the surprising results of our investigation is the fact that parallel experiments with brook trout have failed to show any beneficial results from the addition of oil and yeast. In fact the controls have in all cases shown a superiority over the vitamin lots both as regards mortality and growth. Brook trout were first used in our experiments during the summer of 1924 at the White Sulphur Springs Station and it was thought that the contradictory results obtained might possibly be due to the fact that, as past experience has amply shown, conditions at this station are not suited to brook trout. However, experiments at the Holden, Vt., station, where conditions are favorable for brook trout, have, so far as they have progressed, given similar results and it is evident that we must look further for an explanation of the failure of oil and yeast to prove beneficial with this species. What this explanation is we can, as yet, only conjecture, but possibly the fact that both heart and liver have been recently shown to be much richer in vitamins than was formerly thought to be the case may afford a partial solution of the problem. In any case, it is evident that each species of trout presents a more or less distinct problem and that it is not safe to conclude that what is good for one species will necessarily prove equally beneficial for others.

For some time we have felt that too many fish culturists fail to realize the importance of fresh food, especially in the

case of young fingerlings. In many cases the food is allowed to reach an active stage of putrefaction before being fed. We realize that to a certain extent this is unavoidable, but we doubt if there are any hatcheries where considerable improvement could not be effected without great effort or expense. The habit of grinding the food only once or twice a week is very objectionable since, as is well known, putrefaction takes place much more rapidly after grinding than before.

In order that there may be no room for doubt as to the effects of stale food, it was decided to test the matter experimentally, and two lots of brook trout fingerlings, each containing 1,000 fish were set aside for the purpose. One lot was fed fresh sheep liver while the other lot was fed liver which had been allowed to stand several days until a distinct odor of putrefaction was noticeable. At the time of writing the experiment has been running seven weeks and the total mortality to date in the lot fed fresh liver is 86 or 8.6%. In the lot fed stale liver the mortality totals 272 or 27.2%. There is also an appreciable difference in the growth of the two lots, the average individual weight in the lot fed fresh liver having increased from .445 grams to .957 grams, while in the lot fed stale liver it has increased only from .412 grams to .652 grams.

While it is true that the stale liver used in the experiment was in a more advanced stage of decomposition than that ordinarily used for fish food, it was in no worse condition than we have frequently seen fed to trout fingerlings without exciting special comment. On the other hand, owing to the fact that we were unable to get a fresh shipment of liver oftener than once a week, the "fresh" liver was by no means as fresh as we would have liked to have had it.

We believe that this experiment shows conclusively the importance of using every precaution to insure that the food used in our hatcheries is at all times as fresh as possible. There can be little doubt that a considerable percentage of the mortality among trout fingerlings is, in many cases, at least, directly due to stale food and that the exercise of more care in this respect will result both in decreased mortality and in increased growth.

Discussion.

MR. LAIRD: I have started an innovation in fish food that may be of interest. I do not know whether it would work at any other place. I am right on the sea shore down on Long Island. The scallop boats come in there and the waste from the scallops is used as bait for eel pots.

It is also good bait for other kinds of salt water fish. These boats go thirty or forty miles off shore and dredge for scallops. I can buy this material for about fifty cents a bushel, and I have been feeding it to the trout for two or three weeks at the rate of four bushels a day. I have wondered if the same use could be made of the waste prevalent on the inland rivers in connection with the baroque shellwork. I know it is good food. I have not made any test to see whether there is any increased growth in the fish or whether it is better than a meat diet, but I thought it would be interesting to you folks to know about it.

Another thing I am doing in connection with feeding is to make use of the waste from the traps that are set in the waters around Long Island. These traps are common fish pound traps in which they take fish of all kinds and descriptions. After the fish have been taken out and shipped to New York, there are left what they call the culls or undesirable fish for which there is no sale except to duck farms. These fish available for trout feeding consist of ling, bonita, skate, logfish, small mackerel, small bluefish, spearing, silversides, squid, whitebait, and so forth. These fish I get perfectly fresh as the traps are emptied early in the morning and the boats get back to their docks before noon. I get the fish, bring it immediately and feed it to the trout before there is any chance of softening or putrefaction, and the fish are fond of it. I would like to know whether the grinding up of this fish and the breaking up of the liver and entrails takes away from the value of the fish as a food. I would like to know also what the vitamin content of this food would be.

MR. PAYNE (Kansas): What was the amount of this food used, what was the size of the fish and how many took the food?

MR. LAIRD: I have about 35,000 fish about eighteen months old and they will clean up the whole works in just a few minutes. They get mostly two feeds a day, one of scallops in the morning and a feed of fish in the afternoon, and probably the next day a feed of fish in the morning and a feed of sheep's plucks in the afternoon. I do not provide for one special food to give them from day to day; I try to break it up so that they do not get the same thing all the time. Thirty-five thousand fish, 14,000 rainbows and the 20,000 brook trout will clean up eight bushels of scallops in a day, so they like it pretty well.

MR. TITCOMB: How do you serve it?

MR. LAIRD: I run it through a food chopping machine, No. 156, using a three-eighths plate, enough to break it up so it will not give them any trouble getting it down.

MR. TITCOMB: You give them all the scallops except the marketable part?

MR. LAIRD: Yes everything except the shell and the eye.

MR. LEACH: I am of the opinion that scallops, fresh water mussels, liver and such foods contain a great deal of water, and for that reason

their real food value is rather limited. We know from analyses that have been made that the protein content, for instance, of scallops and fresh water mussels is very low, so it looks to me as though you were feeding the fish a great deal of material that is not of much value, and that unless you can get it very cheap you are not gaining very much in feeding it. The Bureau is establishing what we might term a fish sanitarium at the Holden station, Vermont, and Dr. Davis is conducting experiments up there which he expects in time he will be able to continue the year round. He is feeding young trout and expects to hold them until they get to the adult stage, if they survive the different classes of food, and we believe that in time a great deal of good will come from that experiment. I think any practical fish culturist who has handled young trout will be certain that when he feeds beef heart or some food that has a great deal more substance to it he is getting far greater results than when he feeds beef or sheep liver or fresh water mussels.

MR. TITCOMB: This question about liver and hearts, I suppose, can be determined by experiment. It seems to me this idea of scallops for hatcheries along the coast is a very good one.

DR. RISER: I have grown fish for fifteen years for commercial purposes and my object is to feed the fish so as to get them to the proper size as early as possible. I feed beef lights to the adult fish—beef, sheep and hog lights; I prefer the beef and sheep lights. But I cook every bit of my food thoroughly. Some say it is not natural for a fish to have cooked food. Well, it is not natural for a fish to eat part of a cow either. You are preparing this food artificially and you must make it digestible. I never feed them liver because that makes the meat soft. I do not think there is any subject that is of more importance to the fish growers than the question of feeding. I feed the fry on thoroughly cooked beef liver grated fine, once a day. I do not feed any of the fish more than once a day, and sometimes they have to go without on Sunday. But all the food I feed must be fresh. Where cattle are killed to-day that stuff is cooked this afternoon and fed in the morning; it is devoured in less than twenty-four hours from the time it is killed. I have, to my misfortune, fed some that began to ferment, and the fish ate very heartily of it, especially the young fish three or four inches long, and in less than an hour I had a pool of burst fish. The stuff began to ferment and bloated them; they were absolutely torn open. I am a strong advocate of thoroughly cooked foods. Some say you do not get the vitamins if you cook the food, but we did not hear that word twenty years ago and I have had no bad results in the fifteen years I have fed fish.

MR. TITCOMB: Before we discuss that, let us get back to Mr. Laird's subject. He spoke about scallops—was that for the young fish or for the adults?

MR. LAIRD: The adults. I do not feed the small fish anything except sheep's pluck and beef hearts. I try to alternate them, too.

DR. EMMELINE MOORE: It seems to me that Mr. Laird will find a beneficial result in the varying of feeding by introducing these fresh sea foods, for the reason that they will contribute minerals which assist in assimilation, even though they are not rich in proteins.

MR. LAIRD: I had in mind the iodine in the sea food. I thought perhaps that would be a beneficial factor.

MR. TITCOMB: Has anyone here had experience with the extensive feeding of whiting?

MR. KEIL: I think Mr. Hayford has had as much experience in feeding salt water fish as anyone present.

MR. HAYFORD: This food business is a big problem with us because we have to have around 175,000 to 200,000 pounds a year. We have tried pretty nearly everything. Last year we put out a million fingerlings two to five inches long and almost a quarter of a million trout from six and a half to fourteen inches long, and we tried almost everything in the sea food line, as well as the meats. At first we started in with the pig's liver. It worked out very well under our conditions. Then we used grated beef liver, pork melts, beef melts, calf melts, butterfish, whiting, and the shrimp from Louisiana, and then worked in a lot of natural food. But we have worked it out now so that we get the most rapid growth from the sheep's plucks with about ten percent of shrimp bran ground into the food—that is after the fish get about two inches long. What that shrimp bran does I do not know, but it supplies a need of some kind, whether it is iodine or something else. We have less disease and we get away from that softness that has been spoken of. Taking it all in all, the results are satisfactory and the fish are more gamey. New Jersey is a small state; there are good roads and you can drive about the streams in almost two hours. In order to get results we we have had to put out most of our fish at above legal size and we get much complaint from sportsmen about the softness of the fish due to the feeding of liver, etc. But since we went down to sheep's plucks and the shrimp bran, as far as I can see—and I do a great deal of fishing myself—the trout is just as game out of the hatchery as he is when raised up stream. He is hard and firm, and the nipping of fins has been overcome.

MR. LAIRD: Doesn't that softness leave the fish after it has been in the environment for a week or two? Sometimes they are caught so soon after they are put out that they have not a chance to get firm.

MR. FRANTZ: We have been feeding Mexican Pinto beans for the last year. We cook them almost to a pulp, grind them thoroughly and mix them with beef lights. I have got fish practically all the way from three to three and a half to the pound in eleven months—very seldom less than three to the pound. The beans can be bought at \$1.20 a hundred.

It makes the cheapest food I know of and thoroughly mixed with beef lights it produces wonderful results. It is rich in protein, and there has been no loss among the fish. The beans are so near the color of beef lights that when ground up with the lights the fish take it readily.

MR. TITCOMB: Is this for trout?

MR. FRANTZ: Yes, rainbow.

MR. TITCOMB: Are these beans dry when you buy them?

MR. FRANTZ: Yes, we buy the dry beans, cook them pretty thoroughly in a pressure cooker, and then grind them with the meat. The fish do better on this bean than they do on beef lights alone. The regular beans are sixty-seven cents a pound, but we buy the "cracks", which range in price from seventy-five cents to \$1.50 a hundred. I may mention just here that my place is in Colorado Springs and I would be glad to have any delegates who go there to come out to my place. I am a mile from the center of the town. We have what we consider a very fine establishment. Dr. Riser here is one of the pioneers in Colorado. I think most of the commercial fish growers who have started around this state have got a great deal of their information from him.

MR. LEACH: Are the beans cooked by boiling in an open kettle?

DR. RISER: Under pressure, live steam. We use an ordinary steam boiler.

MR. FRANTZ: Could Dr. Moore tell us how the beans compare with meat as to protein value?

DR. EMMELINE MOORE: No, I cannot.

MR. FRANTZ: I always heard they were rich in proteins.

DR. EMMELINE MOORE: They are rich in proteins, but I cannot tell you the percentage.

MR. FRANTZ: It is very easily digested, too.

MR. TITCOMB: Does anyone want to ask any questions of Mr. Frantz about his new food? It seems to me that it is worth considering.

MR. LEACH: We find that young trout do not digest the starch in wheat and other carbohydrates.

MR. FRANTZ: There seems to be quite a difference between the starch in the beans and the starch in wheat. I tried feeding shorts and my mortality was great before I discovered my mistake. For the trout soon after the sac is absorbed and up to a couple of inches long you can take some shorts; it does not seem to affect them. But I start feeding beans to my trout in the hatcheries as soon as they are old enough and it does not seem to affect them at all, although they won't stand wheat.

MR. LEACH: If whole wheat is sprouted and then ground, that breaks down the starch and turns it into sugar. Probably wheat flour could be successfully fed to the little fish under those conditions.

MR. PAYNE: Do you gauge the amount of food for the fish?

MR. FRANTZ: In feeding commercial trout we give them just about what they will clean up thoroughly. We want them to clean everything up and be hungry all the time.

DR. EMMELINE MOORE: Beans and peas are supposed to carry over fifty per cent of protein. That is as near as I can come to it—fifty to sixty-five. I do not remember the exact percentage.

MR. TITCOMB: Did you not mention peas as well as beans?

MR. FRANTZ: No, I did not mention peas. I suppose they would work out the same way if we could buy them cheap enough, except that peas are green and the fish might not take them as readily as they do the beans on account of the difference in color. We have fed it without any meat, or with meat—either way.

MR. TITCOMB: I would like to ask Dr. Riser whether he mixes any cereal with his meat when he bakes it?

DR. RISER: Not if I have enough meat. If I am short on meat I have to mix shorts with it. But the rainbow trout seem to do better on straight meat. There is always enough blood in the lights to make good strong feed.

MR. TITCOMB: In connection with Mr. Laird's feed, you all realize you cannot change quickly from one food to another. That is, if you have been feeding beef hearts steadily for two or three weeks you would not change immediately to liver without mixing the two, perhaps; otherwise you might get disastrous results. Mr. Laird, I see, is mixing his food every day so that the fish are getting a variety. It is well to note in this connection that when you examine the stomach of a wild trout you find a great variety of food in it. Of course a large amount of the stuff taken into the stomach of a wild trout is absolutely waste; there is no food value in it—it is what I call roughage. It seems to me it is a good thing to work into the artificial foods some roughage where possible.

MR. LAIRD: I would like to hear somebody talk about introducing green stuff into the food. Did I understand Mr. Frantz to refer to the feeding of green stuff—vegetable matter?

MR. FRANTZ: No, nothing but beans. That is all I spoke of.

MR. LAIRD: Take some of the pond weeds—Potamogeton—would they have any additional value to the fish? I imagine the fish get more or less of that in nature. Has anybody used it at all?

MR. HAYFORD: Sometimes the fish will take off practically every leaf of this stuff and they will be all filled up with various vegetable matters. It is a question in my mind whether they go after that vegetable food for the vegetable matter itself or for the various little insects that are attached to them. We find them at times gorged with it. I used to make the men keep the green stuff off the side of the pond; now I leave on all I can.

MR. LEACH: One of the state fish culturists told me that in feeding a meat diet to young fish they scraped a certain amount of moss and other stuff off the rocks in the streams and mixed it in with the food. They claimed that very beneficial results came from feeding the fish in that way. Of course it is not always possible for a large plant to ob-

tain sufficient of the algae and other material to feed the fish, and I suppose one would have to be very careful as to the quantity of that stuff that was mixed in. At our Erwin, Tennessee, station we are feeding beef heart to our fish for about six weeks and then we change off to beef liver or sheep liver because it is cheaper per pound. We experimented with the feeding of whole wheat flour. We had been paying about \$2 or \$2.25 a hundred for shorts and such material, so we bought a burr mill, burred our wheat, ground it and fed the whole wheat just as it came from the mill—ground it up very fine. We experimented with several lots of fish for periods of thirty to sixty days. We found that the fish that were fed say ten ounces of meat a day showed greater gain than fish that were fed the same ten ounces of meat and four ounces of flour which were prepared by cooking. We found that the fish that we fed six ounces of meat to four ounces of cooked flour showed a very decided loss in weight and also a considerable loss in mortality. So we reached the conclusion that we were not gaining anything in feeding a mixture of flour to young fish. About the same time Dr. Davis made some experiments in which he showed that the young fish would not digest the starch in the food, so we concluded that it was not wise to feed such material to small fish. At York Pond station we have been fortunate in securing what is called fish scrap—fresh trimmings from catfish and other fishes obtained around Gloucester. It is shipped to us iced and then fed to the fish. We can obtain it for about three to three and a half cents a pound delivered. I believe such material contains a great deal of food value for small fish. It is well once in a while to give them beef heart or beef liver or some other food in addition to this straight diet of fish. Fish do better on a mixture of food than on a straight diet.

MR. LAIRD: Is there any danger of the small bones in the ground fish food penetrating the stomachs of the small fish? Can the small fish assimilate the bones?

DR. EMMELINE MOORE: That is something I have not examined at all I do not know whether a fine grinder would take care of that or not. A bone will penetrate a heavy wall of muskellunge and do it so effectively as to kill the fish. That I have seen again and again.

MR. LAIRD: Do you mean the bone or the spine?

DR. EMMELINE MOORE: Spine. I do not know about the bone. It is relatively soft.

MR. TITCOMB: That question was brought up last night; one of the men spoke of cooking his fish so as to soften the bones. Would that do?

MR. BENGARD: The sucker fish has a small forked bone in between each layer of the flesh. It has three prongs on it and it feels very soft—hardly any stiffness to it. You grind that up very fine and feed it, and in a day or two you will find little fish turning with their bellies up, and if you examine them you will see these little bones sticking out from

the gills and all through the stomach, one-sixteenth of an inch long, perhaps. It is evident that they will work right through, and for that reason I have decided to use the pressure cooker method. It is said the addition of an acid will soften the bone, but of that I do not know.

MR. LAIRD: I have not fed any ground fish to very small fishes—only to those over six inches long. I do not dare to try it on the small ones.

MR. TITCOMB: The use of cereals has been tried quite a good deal in the commercial hatcheries. Mr. Cobb is familiar with one case where they used a Ripley cooker to boil the cereal and then mixed it with the raw liver after it was cooked. In all these food discussions I think you all have in mind growth as an objective, with a minimum percentage of loss and at a minimum cost. When you prepare livers of the different animals and beef hearts or other hearts you have got to consider the percentage of waste in each particular food. I asked Dr. Davis this summer if the problem had ever been worked out as to the comparative cost of the different foods for producing a certain number of fish at a given size. In other words, you may pay six cents a pound for liver or you may pay ten for heart; the question is, after feeding for three or four months, which of these foods has given you the best results in poundage of trout. That is what we are after and that includes the avoidance of disease. Has anyone worked that out on any line so as to be able to give a specific answer to the question? It seems to me it is one we should all work on.

MR. LEACH: The Bureau has been keeping a record at several of the stations of the food used in feeding different sizes of trout. For instance, we keep a record of the amount of beef heart fed to a thousand fish of certain sizes and we try to keep that record all the way through and even apply it to the adult fish. So that several of our stations will make pretty full reports in that way of the amount of food used, whether beef hearts, sheep liver, beef liver or any of the mush foods made from wheat.

MR. TITCOMB: You cannot compare the results at one station with the results at another. With the same foods you get different results at two different hatcheries with two different water supplies. Each hatchery has its own problems and each man who is interested in this subject has to try these different foods by setting aside certain troughs or pools of the same size as other troughs and pools and keep a record of what he has fed in each lot and what he is paying for the food for each lot, and then weigh his fish at the end of the time and see what he is getting.

MR. LEACH: We do that.

MR. KEIL: Very often these experiments are not representative, that is, they do not show in a general way what would apply on a large scale, because there is just a small number set aside and they are given greater attention than the majority of the fish from that hatchery. Do you not think that is true?

MR. TITCOMB: Well, you have your units. Has Mr. Hayford tried it with his different units?

MR. HAYFORD: Three or four years ago I had an article in the Transactions showing the results of experiments with different kinds of food. We took different sized fish in twenty-five or thirty troughs—brook trout an inch to two inches long, rainbow an inch to two inches, brown, and so on—and it was very interesting to see the different results obtained from the use of different foods. The problem is quite a large one, but I worked out these six different combinations as rations for fingerlings, none of which will hurt the fish:

No. 1. 85 per cent plucks; 15 per cent chic chuk. \$3.81 per cwt.

No. 2. 85 per cent plucks; 10 per cent chic chuk; 5 per cent shrimp. \$3.84 per cwt.

No. 3. 85 per cent plucks; 15 per cent clam meal. \$4.94 per cwt.

No. 4. 85 per cent plucks; 10 per cent clam meal; 5 per cent shrimp. \$4.64 per cwt.

No. 5. 85 per cent plucks; 10 per cent chic chuk; 5 per cent clam meal. \$4.14 per cwt.

No. 6. 85 per cent plucks; 15 per cent shrimp. \$4.04 per cwt.

A hatchery in Pennsylvania lost all their brook trout and they attributed it to the bones in the intestines. Two hundred eyed eggs were shipped to an aquarium at Washington, mailed in an envelope. They hatched 199 of these trout. They started them off on nothing but butterfish and when they were three or four inches long they had never received any other food. So that shoots your bone idea all to pieces.

MR. LAIRD: I run the whole thing right through, whatever happens to come.

MR. HAYFORD: You might get into trouble that way.

MR. LEACH: We fed our rainbow trout at the Manchester, Iowa, station, coarse fish from the Mississippi River. We cut off the heads and fins, ground them through the machine and fed them to the adult trout for three or four years with very beneficial results. The only trouble we had was that the ponds were littered up with a good deal of grease. But as to the fish, there were never any indications that the bones gave any trouble.

As to the experiments that have been mentioned, when the Bureau gets hold of these fish foods, they are sometimes no more than fertilizer. We sent a sample to the Erwin, Tennessee, station with instructions to feed it to a thousand fish and set aside a thousand fish in another trough and feed them the usual amount of food. These fish are all actually counted. We feed them say thirty days and keep an accurate record of the loss. The same is done at White Sulphur Springs, Neosho, and one of our New England stations, so we have a check up from three or four different sources. I have always felt that if you send a particular fish food to a certain station and ask them to experiment with it, if the super-

intendent thinks you are interested in that food and would like to have it a success he is apt to give it a good report. But when you tell the superintendent that the same material is being sent to other stations, without telling him what stations, he will keep a close record and give a fair report. We have therefore received very interesting and accurate reports, and they show in almost every instance that dry or desiccated food so-called fertilizer, is of no value whatever in feeding young fish.

MR. FRANTZ: I have found in feeding the beans with the meat that I have got a great many of the trout in eleven months instead of fourteen. That is the only record I have to show the advantage of beans over the meat. There is another point: when I cook the beef lights they shrink considerably, but when I cook the beans they increase in weight. It may be largely water, but you get the weight, and I can feed about half the amount of beans that I would of meat. Apparently the fish get just as much nutriment out of it, and it is the cheapest food I can get.

MR. TITCOMB: I think it is well worth trying. It seems to me it is a laboratory problem for every hatchery. Dr. Davis' work will help us as to the comparative cost, etc., of these foods, but I think Mr. Hayford's should never be discontinued. I do not believe Dr. Davis could ever get around to all these foods if he worked a lifetime on it. May I ask Mr. Hayford whether in his experiments he has been able to note the growth and the losses as compared with fish fed in the usual way?

MR. HAYFORD: I have not got down to that yet. But I do not think that Dr. Davis or any other scientist can do more than lay a foundation. For instance, we have five or six different types of water at Hackettstown, all showing different analyses, so that a method that might work well in one section will not do at all in another. We can get the foundation and then each hatchery must work out its own problem with what scientific help is available to him.

MR. TITCOMB: I have in mind one hatchery in New York state where the water is supposed to contain a superabundance of oxygen. We tried different foods there and we found that we could not feed anything but beef liver without serious loss. The water at the hatchery may determine the kind of food that you have to use, just as it does in that particular station, where you can get along with almost no loss on beef liver but if you use the other animals' plucks or liver you have trouble.

MR. LAIRD: I would like to speak about feeding these small fish. I feed the small fingerlings, an inch and a half long or so, three times a day. Mr. Leach spoke last year of making some kind of carrier to hold the beef hearts in the trough in the form of a lump so that the fish could pick at it. I take an ordinary spawning pan, punch a hole in it so that it will sink and stand in the water so that the rim is just under the water. Then I take a lump of plucks—dry, without mixing it up with any water—put it right in the pan and let the fish have something to work

on all the time in addition to their three regular feeds. The pan is suspended so that it cannot go down to the bottom and the fish take off little pieces at a time.

DR. EMMELINE MOORE: This discussion of the different types of feeding and the difficulty we have in getting at a possible ration illustrates very clearly the point I made in my paper, that we need to multiply the laboratories and laboratory centers from which such information can come well formulated and ready for our hatchery force to take over.

MR. TITCOMB: Would you have a laboratory in each hatchery?

DR. EMMELINE MOORE: No, not necessarily. In New York state, for instance, we have twelve hatcheries. It would be impossible for us to have laboratory facilities that are adequate in our twelve hatcheries. But it should be possible for us in New York state so to coordinate our problems that we may be able in the course of a few years to develop at one of our laboratories in natural science—we have two state laboratories in natural science—a proper conclusion to some of these questions. That, I think, each state should certainly aim to do it in its state laboratories.

DR. RISER: In feeding fish the most essential thing is to use common sense. In very hot weather, for instance, you should cut down on the food, otherwise you can kill more fish in one night than you ever thought you could. We must study conditions and use common sense.

MR. CULLER: I would like to ask the fish culturists here if any of them who have fed beef hearts or sheep heart to the small fish have had bad results from such feeding?

DR. RISER: I never use anything but liver straight.

MR. CULLER: If no one has had bad results, why not use it?

MR. LEACH: It is a question of cost.

(Mr. Titcomb here read Mr. Wallich's paper.)

REARING TROUT TO THE FINGERLING STAGE.

CLAUDIUS WALLICH.

After I had worked about six months in the capacity of a fish culturist, I felt rather sure that I had mastered the subject. At a year, I was sure that I had, and at two years I was a regular professor on the subject. At five years, I began to feel that there were just one or two little things that I was not sure about, and since that time, the number of little things that I felt that I was not sure about, have been increasing so rapidly, that now I would not make a statement under oath, that I know anything at all about the subject. I say this now, so that you will not be tempted to attach undue importance to the few notes on the subject of rearing trout fry to the fingerling stage that I am about to present.

In the first place, I believe it to be necessary to fully realize, that the water the fish inhabit, is their breathing medium. It is their air, and just as we humans are realizing that more and more pure air is a prime essential to health, it is necessary to realize that the water for fishes must be kept clean and pure. With clean gills, fish are able to overcome a number of adverse circumstances, and in artificial propagation it must be admitted that adverse circumstances occur with some regularity. If there is one admonition that is reiterated more than another at the Springville station, it is this, "do not foul the water in feeding your fish." In the early days of fish culture, when the quantities handled were limited, the method of feeding young trout fry in the earliest stages, by means of a feather dipped in the food and drawn swiftly down the center of the surface water in the trough, was quite satisfactory, but required too much time if done adequately. One man could scarcely cover a battery of 120 troughs three or four times a day and be sure the fish were all fed. The pressure box feeder with bulb attachment and with minute holes in the bottom of the box, through which the food issued in tiny threads, was an efficient mechanism when livers were used as a food, but the mechanical difficulties experienced in keeping it in good working order, made its use impracticable, and it was found not to work well when beef hearts were used as the food.

The method of feeding adopted at the Springville station right from the beginning of feeding the youngest fry, is to allow the food to drop quietly to the bottom of the trough in three or four favored spots; say a foot from the head, at the center of the length of the trough, and at one or two

points between, the quantity varying from a teaspoonful to a tablespoonful according to the requirements of the fish.

When hearts are used, they are run four or five times through the smallest plate and fed fresh ground. If the food has been previously prepared, it is run through the chopper again just before feeding. No water is mixed with the hearts. When it is fed in this manner, it is readily broken up by the youngest fry, rising in small clouds of tiny flakes, readily seized by the fry, and without pollution of the water. When the food is liver, the admixture of water is necessary, the amount of water used depending on the age of the fish and their ability to break it up. The food is worked up to a smooth batter and dropped quietly to the bottom as before.

It has been the experience at the Springfield station, that a straight meat diet, indefinitely continued, is not conducive to proper elimination. One of the first signs of indisposition on the part of the fish is a scanty showing of excrement at the foot screens. A correction for this condition has been used experimentally for several seasons at both the Federal and the State hatcheries at Springville, and during the past season, intensively, at the Federal hatchery, and consisted of strewing a pinch of whole wheat meal along the surface of the water in the troughs once a day, preferably in the morning before the first meat ration. The fish are then keen on food and eagerly snap up particles of the floating meal. As a result of this practice, the station has this year been singularly free from mysterious epidemics, and we have been able to raise a much larger percentage of the fry to the fingerling stage. The morning ration of wheat meal is fed up to the time when the fish are $1\frac{1}{2}$ inches long. They are then fed a mixture of ground liver and mush, made of the same wheat meal. Livers are better adapted to this mixture than hearts, making a closer combination and giving a better color to the mush. The percentage of mush to liver is at first something less than 50% and may be increased to 75% as the fish increase in size. It must be well cooked and thoroughly ground through the meat chopper together with the meat, when cold and stiff. The mixture is then stirred to a smooth paste, adding a minimum of water to attain this end.

In connection with the above feeding method, it should be stated that all food particles remaining in the troughs, an hour after feeding are brushed out and the fish are thus assured another breathing spell of pure water, making them ready to attack the next meal with vigor. Cleaning out the food remains also enables the operator to check up on the con-

dition of his fish and to realize whether or not he has been wasteful in his feeding practice.

When the fish scurry rapidly away on approach and there is a liberal amount of excrement on the foot screens, you know that your fish are well.

Discussion.

MR. TITCOMB: This paper borders on the subject I was going to bring up after we finish the food discussion, that is, the avoidance of disease. Does anyone want to discuss the food end of it before we take up the question of the avoidance of disease in connection with the raising of trout?

MR. LEACH: I think we ought to have more on the methods of feeding. A good many of the people here have had experience in feeding and they ought to speak of their methods.

MR. TITCOMB: We will call for volunteers to tell us how they feed. Mr. Foster, will you tell us about your work in that respect?

MR. FOSTER: We had the best success in using the old shaker box—put your ground beef heart in a shaker trough with a shaker box and start your fish off with that in the troughs. Under normal conditions, where we did not have a parasitic attack or something like that, we would bring through ninety-nine per cent; in other words we lost one fish per thousand in thirty days. If you can beat that in any other method of feeding young fish, you have to show me. We use that shaker box up to the time the fish are an inch and a half long, then we put them out in the troughs. I think a mistake made by many fish culturists is in grinding the beef hearts or liver too fine with the result that it all goes to mush in the water. The more you can feed the fish on the larger particles the better results you will get. Some fish culturists say you will choke them if you do that, but I have not seen more than half a dozen cases of choking on account of the large particles. There is perhaps no place in the United States where the fish grow any faster than they do in Missouri, largely due to the warm temperature of the water down there. But we do not try to force them at the hatchery, for two reasons: if we try to force them too much for fall delivery the fish are too large and we cannot handle them. If we hatch out our fish along in the spring, February and March, and feed them what they would eat, we would be putting out half pound fish by October.

MR. TITCOMB: That is what we want.

MR. FOSTER: Yes, but your distribution cost will run so high that you will not have the money to put them out. I have seen a pound trout produced in Missouri in ten months, fed on beef heart and sheep's liver—start them on beef heart for six weeks and then shift to sheep's

liver. It is not a question down there of variation of food; if there are no parasites and reasonable care is taken in feeding you can bring your fish to any desired size within a limited time with very little loss.

MR. TITCOMB: How is that shaker box made?

MR. FOSTER: Take a piece of perforated zinc such as is used at the foot of the troughs, the size of the perforations governing the size of the fish. Make a small box with a handle, say about six inches long and four inches wide, into which you put your food. Just submerge the lower part of the box in your trough with a jerking motion and your food comes out and is spread in the trough. Every fish gets a chance at it in a short time. Use food enough so that they can clean it up in five minutes after you are through with the shaker. We do not try to feed all in one trough at a time; we will go over a trough about three times. But the last feed is sufficient so that there is enough remaining in the bottom of the trough to enable the fish to clean it up in five minutes. You can begin at the foot or at the head of the trough, usually depositing a larger amount at the head. Shake some out sixteen inches from the foot of the trough so that the weaker fish at the bottom may get the food. If you get any weaker fish down there, make sure they are getting what they should have. The food is not mixed with water; it is put in clear as it comes from the grinder. It is preferable to grind it every day instead of grinding a large quantity and putting it in the ice-box. The coarse stuff that does not go through the shaker box is fed to the larger fish. The size of the perforation at the start is about five sixty-fourths, possibly a little coarser than the fine plate.

COLONEL WOODS: How high would it run?

MR. FOSTER: Until the time when they are put out in the ponds and fed with the spoon they would run about one sixteenth. That is about as large as we use in the shaker boxes. Only two sizes are necessary, a fine size and a large size.

MR. TITCOMB: How often do you clean the troughs?

MR. FOSTER: Once a day. The cleaning should be done preferably along in the afternoon before the last feed is given. The feed at night should be possibly a little heavier than at any time during the day. If there are troughs you cannot do you have to start in the morning and have one man start cleaning the troughs after the first feed in the morning. Use the shaker box at first five times a day.

MR. RISER: If I had my way I would never feed little fish in the trough. Last winter I had to put out 80,000 of my fish because I was crowded in the hatchery. I put them in the pool as soon as the egg sac was absorbed and none of my fish ever did better than that lot did.

MR. TITCOMB: What percentage of fingerlings did you get from the 80,000 sac fry you speak of?

MR. RISER: Seventy-five per cent. The fish have done better when put out of the trough as soon as the egg sac is absorbed.

MR. TITCOMB: That brings out the fact that there is a great difference between the commercial trout breeder who is raising trout for the market and the man who is merely raising fingerlings for distribution. If I may interpose just here I was going to suggest that we talk a little about the avoidance of disease. I have here the floor plan of a hatchery; it is not accurately drawn, but fairly so. We are raising our fingerlings up to five and six inches in troughs. We have 72 troughs in this hatchery of which you see the floor plan, and 120 below the hatchery. The water passes through the hatching troughs and then is passed through the outside troughs, supplemented by additional water. This plan shows only the hatchery floor. It is very conveniently arranged. The point I want to bring out in connection with the plan is this: every trough has two discharges. The troughs are set in pairs and the upper two troughs have a discharge pipe to an open drain that is closed with a plug which has a handle. When the plug is closed the water passes through a pipe at the end of the upper trough into the second tier and then there is at the end of the second tier another plug for the outlet or waste drain. The water is carried through the under trough into a pipe and discharges into what we call the clear water line. That clear water line discharges into the troughs outside. When the feeder or fish culturist cleans the trough he begins with the upper pair, pulls the two plugs, and the water and waste discharges into the waste drain. The troughs are brushed down clean, the plugs are replaced, and he does the same thing with the second of the tandem set. That waste goes into the waste drain and then the water continues on into the clear water line. Every time the troughs are cleaned the excrement and foul matter goes into the waste drain and is carried below all our constructions, below all our pools. We expect to use all that water over again down in the brook pools. This water that goes through the waste drain will be discharged into a settling basin, so that when we want to put in a duplicate of this plant half a mile below, we have a clean brook, and we intend to discharge that brook into the fishing waters below as clean. That is one point in the matter of avoidance of disease in the lower waters.

The other advantage in this arrangement is that if we discover in a set of troughs in our hatchery or in a set of troughs in our rearing plant outside any symptoms of disease, we immediately pull the plug and discharge that water into the sewer line, continuing so to discharge it as long as we have any disease in those troughs. That prevents the transmission of disease from one lot of fish to another. We had a little fin trouble there this summer and it was mighty convenient to be able to do that. These troughs in the hatchery and the troughs outside are full of trout three to four inches in length at the present time, and at this time of year they double their weight in ten days. We begin to distribute four-inch fish; we keep sorting as fast as we ship out, and we continue to ship four-inch fish until we reduce the number down to

what the troughs will carry. We eventually expect to distribute out of the troughs 100,000 six-inch fish, or carry some of them over in pools. We have only a few pools because our water supply at the present time is limited to 500 gallons, all developed on the place. These pools are also arranged so that when we begin to stir up the foul matter after drawing off the clear water of the surface of the pools, that also is discharged into this sewer line, and when it gets back into the brook we intend to have it clear water.

MR. BENGARD: When you pull the plug and run that water into your sewer, the question occurs to me how do you get it into your lower troughs during that time?

MR. TITCOMB: We can only use a pair of troughs at that time. If we have trouble of that kind at that time we try to use the lower pair.

MR. BENGARD: And if your fish are healthy in the lower trough—

MR. TITCOMB: Then we draw the plugs in the upper ones and remove the lower fish to other troughs.

THE ADVANTAGE OF REARING BROOK TROUT FINGERLINGS FROM SELECTED BREEDERS.

BY GEORGE C. EMBODY AND CHARLES O. HAYFORD.

It is well known that brook trout held under the artificial conditions obtaining in hatcheries are subject to many diseases. Some of them are due to external parasites infesting various body parts such as the gills and fins. These may often be controlled by dipping the affected fish in one of several solutions designed for the purpose.

There are other diseases, however, caused by organisms living within the body such as *Bacterium trutta* occurring in the blood and *Octomitus salmonis* inhabiting the digestive and possibly other organs. These internal parasites cannot be reached by the various solutions just mentioned and in fact a control cannot be obtained by any therapeutic treatment known to the writers. It seems to be the concensus of opinion among both European and American investigators of fish diseases that the surest method of control lies in preventative measures, either in the prevention of infection or in developing a resistance in the trout through feeding or by means of selective breeding.

In the New Jersey State Hatchery during the years 1915 to 1917 inclusive, some difficulty was experienced in rearing brook trout to lengths varying from two to six inches. It was believed that the trouble was due to *Bacterium trutta* or some closely related organism occurring in the blood.

One line of work, that of selective breeding, suggested itself to the writers as worthy of trial even though definite results could not be expected before several generations of trout had been produced and therefore before the lapse of several years.

We were influenced to try such a procedure because of the astonishing results obtained by breeders of domestic animals and plants and also by the belief that trout culture had not been profiting as it should from the recent advances in the field of genetics and animal breeding.

The experimental procedure and results briefly reported here must be considered as merely preliminary to a larger series of breeding experiments now under way in the Hackettstown Hatchery and in Cornell University.

Certain difficulties encountered in the rearing in separate troughs of progeny from selected pairs made it inexpedient for us to attempt close inbreeding which has produced such grati-

ying results in the case of domestic animals. The only kind of selection possible was mass selection in which we were aided by natural agencies.

In February, 1919, 43,000 fry were selected from the best stock available in the hatchery. These were held in hatching troughs of regulation size and fed upon ground liver prepared in the usual way until early in May when they were transferred to outside ponds of concrete construction. The mortality soon became very high. However, the trout were not treated in any way for the trouble and the disease was allowed to run its course. On July first, the fingerlings were counted and it was found that the total loss amounted to about 97.6% (98% if reckoned from the eyed-egg stage). The average length of the fingerlings on this date was close to two inches. It was believed that the disease would kill off a large proportion of the nonresistant trout.

In November, 1920, there remained about 344 of the original lot of 43,000. These were stripped and the resulting eggs hatched into the A_1 generation. The trout comprising this new generation were treated similarly to those of the original lot. The concrete ponds were the same as had been used two years previously and were not sterilized. Apparently the same disease broke out among them and by early July the mortality amounted to 46%.

The A_1 generation became sexually mature in November 1922. At this time the largest specimens were selected and stripped. These eggs were kept separate from the others and in due time hatched into the A_2 generation. The same treatment was accorded this generation as with the others and the mortality up to the following July, 1923, was only 31.8%. In addition to this the fingerlings had increased in length to about three inches.

The A_3 generation was derived from a selection of the largest and most highly colored breeders among the A_2 generation. The mortality up to the fingerling stage in July, 1925, was 30.8%, a slight decrease over 1923. The average size of the fish at this time was also greater than that of the A_2 's and there was much less variation among them.

It is well to mention here that the bacterial infection occurring in the original lot as well as in the A_1 generation, did not appear in the two succeeding generations. However, the trout comprising the last two generations became heavily infected with *Octomitus* notwithstanding which there was a decided drop in the mortality figures up to the three and four inch size.

The results of the experiments up to July 1925, are compared in the following table:

	Strain A			
	1919 A	1921 A ₁	1923 A ₂	1925 A ₃
Mortality from eyed-egg stage				
to July fingerlings	98%	46%	31.8%	30.8%
Average length in inches of				
July fingerlings	2	2	3	3½-4

In order to be able to refer definitely to this particular ancestral line of trout, we have designated it as strain (A).

It was thought that at some future time we might wish to outcross individuals of strain (A) with those of some other unrelated strain having equally good characters. Hence another strain designated as (B) was started at the same time as (A). The cultural procedure in both cases has been the same and strain (B) has generally behaved in the same manner as (A).

In preliminary experiments of this character one would not be justified in drawing more than tentative conclusions. We would therefore do no more than to call attention to the following advantages as apparently having been derived from a very simple kind of mass selection:—

First, that in the course of three generations of breeding, there has been an apparent increase in the average resistance of the trout to the diseases encountered. This is indicated by the marked drop in mortality up to the July fingerling stage from 98% in the original lot down to about 30% in the last generation.

Second, that by the continued selection of the larger breeders of the same age and strain, it has been possible to increase the size of the fingerlings on July first, from two to four inches.

Third, that no loss in constitutional vigor, no lowering of the reproductive capacity, nor any other undesirable effects so far as we know, have resulted from the method of selection here practised.

It is quite evident to us that in order to approach a fixation of desirable characters and to eliminate the undesirable, it will be necessary to practice much closer breeding than we have thus far attempted, probably as close as the mating of brother and sister for several generations. In such a case, should certain undesirable characters appear, we should be able to take advantage of the well known method of outcrossing with certain individuals of strain (B).

We feel that if these promising results continue from year

to year, it will be an indication that one may do quite as remarkable things through the selective breeding of trout as has been done in the case of other domestic animals.

Discussion.

MR. TITCOMB: This paper is open for discussion. We are very fortunate in having one superintendent who has the courage of his convictions and is willing to sacrifice a lot of fish for such an experiment in order to attain such valuable results.

MR. THOMPSON: I wonder if Mr. Hayford is not running into unnecessary trouble when he speaks of crossing brother and sister? I understood it had been very definitely established that the crossing of brother and sister must result in failure in almost every instance.

MR. HAYFORD: I brought out in the paper that if this did show any effects we had this other strain running along all the time under the same conditions. I know Dr. Embury will continue this work. Much interest has been shown in this strain of fish and the result this year is a surplus of fingerlings.

MR. KEIL: Is it not utterly impossible in fish culture to get away from inbreeding as to brothers and sisters, so-called? I do not know how it would be possible to breed otherwise.

MR. TITCOMB: You would not get it continually, of course, in nature.

MR. KEIL: If you carried your own brood stock you would not be getting new blood all the time.

MR. TITCOMB: The commercial trout breeders say that one of the results of the introduction of wild blood is a very slow growth until the new blood becomes domesticated. Perhaps we will get something from Mr. Frantz on that.

MR. FRANTZ: It is a fact that if you introduce wild stock into your breeders when you have taken trouble to breed up a quick growing strain, you will put them back just as you would in the case of any other fish or animal. It is the same in the case of thoroughbred cattle; if you bring in a bunch of cows, you are putting your selected breeders right back. But if you can get your stock from some reliable breeder whom you know has been producing a quick growing strain then you are safe in introducing some new blood, otherwise it is better not to do so.

MR. THOMPSON: You speak about another breeder; would that not imply the introduction of another strain of domesticated trout rather than of wild trout?

MR. FRANTZ: Yes—buy from someone who is breeding trout of a quick growing strain.

MR. LEACH: This is a problem which has confronted the Bureau for quite a while, and I felt it could be solved so far as the Bureau is concerned by what I term selective breeding methods at the various sta-

tions. For instance, if the Erwin, Tennessee, station select their best specimens of rainbow trout, both male and female, they can build up their strain of fish, and we find that that is more satisfactory than to depend on the eggs of wild fish that are shipped in. After a period of a few years of careful selection of brood stock you can build up a strain of fish that is hardier and will produce more eggs and give better results as to size and growth. The Erwin station is doing that, and the Wytheville, Virginia, station and others are doing the same. We find it desirable after a period of years to make an interchange of eggs from these selected stocks in the various stations. We believe that by doing so, through our system of hatcheries, breeding ponds, and so forth, we can keep up a better strain of fish than we can by taking eggs from wild fish and shipping them to the various stations. So we only ship the eggs of wild fish to the stations as a matter of necessity, to make up some deficiencies in the stock; or they may be eggs that are being reserved as future brood stock of that particular station. When eggs are shipped from Madison, Montana or from Pathfinder Reservoir, Wyoming, we always ask the superintendents to use extreme care to send us the very best eggs they can get from selected fish so that we can build up the breeding ponds at the different stations. We feel that the same methods, or practically the same methods, should be employed in fish culture as are followed in the culture of poultry, because the two are very closely allied so far as methods and practice are concerned. But I think less care need be used in fish culture than in poultry culture, because we have greater numbers to work with and we are not apt to have the troubles that may occur in connection with poultry breeding. If the various commercial fish culturists throughout the country had to depend on the introduction of new blood through the securing of eggs from wild fish, I am afraid they would not get very far. Those I have talked to have felt that they can build up their brood stock and obtain better results by the other method—unless some disease gets them, and then of course it is a case of the elimination of that particular lot of fish and starting anew. But disease is just as apt to get into the wild fish as it is to get into the domesticated fish. In fact, I am not so sure that disease may not the more easily establish itself among wild fish that have been brought to a station than among domesticated fish that have been properly fed and nourished.

MR. FRANTZ: Right now I have about 200 wild fry in the hatchery, and they are not more than a third or a quarter the size of those which have been raised from eggs of the domesticated trout. I have the domesticated ones right alongside the wild ones, and there is an enormous difference. That shows that it makes quite a difference when you do breed them up and select them each year.

MR. LAIRD: How can you buy wild eggs? Is it permissible to buy wild eggs in this country?

MR. FRANTZ: Well, I have called them wild eggs, but they are obtained in the western part of the state where several people have lakes under license, covering from twenty to thirty acres. These fish are not raised as the commercial trout growers raise theirs; they are practically in the wild state, and they live entirely on natural food.

MR. TITCOMB: Suppose a commercial breeder has a lot of pools which become the subject of the attack of some disease. I take it from Mr. Hayford's paper that if he has a resistant strain he has then got something to carry on with, otherwise he might never be able to start in over again with wild stock or new stock that had not been subjected to this test. That was your idea, was it not?

MR. HAYFORD: My idea was based on a number of different things. When I was in the Maine Department I worked on wild eggs a great deal. I found there was a great difference between the eggs I got from the different hatcheries as to the way they handled, as to growth and so forth. I wrote to some of these fellows and they were pretty guarded in their replies, but on going to see some of them I was quite interested in the things they had to tell me. The question of exchanging is bound up with a consideration of the conditions under which the different places are working. If a man suggested crossing his selected breeders with mine, and if we were both working under a spring water supply, or, we will say, a limestone water of 52° F., we would probably get good results from the exchange. But if he is working on mountain water which fluctuates in temperature, I do not think the results would be satisfactory.

DR. EMMELINE MOORE: It seems to me that Mr. Hayford's paper sets a high mark for fish culture. I had read the paper twice before Mr. Hayford read it to-day, but on Mr. Hayford's invitation I was fortunate enough to see that experiment under operation. It seems to me we have in that experiment a combination of factors which may make for tremendous progress in the future. We have a fish culturist there who is practical in the extreme and yet who has a sympathy for scientific work. We have in his associate, Dr. Embury of Cornell University, a man whose sympathies are broad in fish culture and whose interests are keenly alive in problems of evolution. The combination is rare, and I believe it marks a new epoch in fish culture.

MR. FOSTER: Dr. Moore has certainly covered the ground. The experiment has been long overdue in fish cultural circles, and the delay has been largely the result of inadequate facilities for carrying on the work, together with a limitation of personnel. I would like to say just a word in regard to the breeding that we have done at Neosho. I went there six years ago, and I think those familiar with the brood stock there will agree that conditions could hardly be worse than they were at that time. We started in with selective breeding, but not keeping account as closely as Mr. Hayford has done, proceeding on a line other than that of extent of resistance to disease. We wanted a better quality of

egg with a cleaner brood stock. One or two other things have developed in the course of the experiment. From taking 150,000 eggs from 1,000 brood fish at two years old, in the six years we have built it up so that we now take 285,000 eggs on an average from 1,000 fish. That amount of production, of course, is important; it cuts down your overhead. At the same time we have advanced the spawning season over a month during that period by breeding and raising for brood stock the first eggs, or those toward the first, that were taken from the selected stock. That does away with much of the cold water handling in February and the latter part of January which was formerly the experience at Neosho, and it also permits the raising of fish to the larger size before the warm weather sets in in the spring. I am talking about rainbows exclusively. The temperatures in Missouri are very high during the summer and the trout are carried under difficulties, so that we prefer to put them out along in February, March and April rather than later.

MR. HAYFORD: We are also running some experiments with the brown trout and Loch Leven, and expect to report upon these later.

MR. LEACH: The eggs from wild fish, say four year old rainbow trout caught in the waters of Montana or anywhere else, will not as a rule yield the same number of eggs, or eggs of the same size, as four year old fish that have been held in the station, properly fed and well taken care of. I think that is one of the results we are trying to attain in fish culture, namely, to get fish that are quick growing and that will produce a good quality of eggs. I believe we are doing that as a result of the methods we are employing at some of our hatcheries. I do not think the average run of fish that are taken from the streams will produce the same results, because in many instances the natural food in the streams must be short, and there must be certain numbers of wild fish that do not produce as many eggs as they should. Mr. Culler has not had very much to say here, but when he was foreman at the Wytheville station a number of years ago they used selective methods in handling their rainbow trout, and I think he will say that during the spawning season, they got a very high percentage of fertility.

DR. RISER: I have had quite a little experience in choosing spawn. A year ago last winter, out of 1,200,000 eggs I did not fertilize ten per cent. Mr. Frantz had a similar experience, and he is seventy-five miles from my place. There seems to be something wrong with the fish. The big fish would shoot from one end of the pond to the other—I called them crazy—and finally they turned up and died. The spawn I took from these fish would not fertilize, although I tried every possible way. I had a few fish that were not fed; they got away from me and they went into a ditch where they had natural food. I remember one in particular: I took 5,175 eggs from that fish and I hatched 5,000 of those, from which I put 2,500 fish on the market. That was a very good hatch compared with the others. But I believe that if the fish could

have more natural food in connection with the artificial food we would get better results. Last year I had 1,400,000 eggs from 447 fish. I thought that was rather a high average.

MR. TITCOMB: You do not think your fish were overfed, do you?

DR. RISER: That might be. I have been trying to find out if that could be the case. I do not think Mr. Frantz overfeeds, because he has to pay more for his feed and he would be a little more careful in feeding. There were neighbors of mine who had the same trouble. I thought it was possibly on account of the weather: it was very warm and then it suddenly turned cold. It was not only the spawning fish that were affected that way; the smaller ones, the yearlings, were the same. Another thing I have noticed is the advanced spawning time. The first spawning I had to do with was about the twentieth of February, and it advanced three weeks every year until it reached the seventh of November. In the last three years I took the first spawn on the seventh of November.

MR. TITCOMB: That is in spring water?

DR. RISER: Yes, spring water, 54°F., as it comes out of the ground. That is not only on my place, it is in the whole section. I think in Utah it is about the same way.

MR. TITCOMB: They spawn on the rising temperature.

DR. RISER: Altitude, I suppose, has something to do with it. My plant is about ten miles from the Brown Palace Hotel. Last year I had a 98 per cent hatch from the wild eggs hatched on the twenty-fifth of July, and many of these fish are ready for market now. I believe I got an exceptionally good bunch of eggs.

MR. TITCOMB: What is your size here for the market fish?

DR. RISER: I sell them when they are from one-third to a half pound. I have fish I hatched in January that are six inches long now—hundreds of thousands of them that size.

MR. CULLER: Mr. Leach spoke of selective breeding experiments that we carried out at Wytheville in 1909. We not only advanced the spawning season to October fourth—I think that was the earliest we had ever taken eggs there—but we also increased the fertility. We also by selective breeding took eggs from fish at a younger age than ever before. In one instance that I remember, out of 1,600 fish, 60 to 70 per cent of the females spawned at twenty months old. Those eggs were exceptionally good, the percentage of hatch being about 92 or 93, which is good for domesticated stock. The average at Wytheville was 82 to 85 per cent, but this year, on approximately 12,000,000 eggs taken in Yellowstone Park, we eyed 94 6/10 per cent. Last year on 32,000,000 it was 89.75. I am firmly of the opinion that while you do not get as many eggs from the wild stock, a better percentage of fertility can be obtained. Our last season in Yellowstone proved that.

MR. TITCOMB: Can we consider this discussion closed? I am going to bring up another subject which is quite foreign to that of trout. Some years ago when I was occupying the position which Mr. Leach now fills we found that we could obtain 20 or 30 bushels of yellow perch spawn on the Missisquoi Bay, Lake Champlain. They did not want them up there; they had too many. I had some of them collected and tried to send them around to produce young perch from, but the experiment was almost an entire failure. Two years ago I found a place on the Connecticut River where the perch congregate to spawn during high water, and then the water recedes about one foot every twenty-four hours. I had the assistance of one of Mr. Leach's men in making the first investigation there. In all we secured 5,000,000 eggs, which we suspended in wire cages on a raft and hatched right there. The following season we did not have the unusual freshet conditions, but this spring when the river was sixteen feet above normal, the temperature conditions were favorable and the perch were spawning on the tops of the willow trees, and we sent boatmen out to collect these eggs as the waters receded. We made some collectors out of apple pickers by putting fine wire around them. With the coarse wire teeth of the apple picker we picked these eggs off into cans, took them to the raft, placed them in these cages and collected about 45,000,000. We found that the best results were obtained by keeping the cages as close to the surface as possible. We first tried having a series of cages in a frame so that the lower cages would be about three feet under the water. That did not work as well. The changes in temperature during the period of incubation would vary 20 degrees between the night and the morning or between early morning and night. This work was being done by a commercial fisherman employed by the commission. I anticipated that they would object to our taking these fish away from the river, but they volunteered the information that they had got such wonderful results from the first year's hatch that they could not draw a seine for live bait without getting it filled up with young perch, and that they had the place full and did not need any more of them. So after these eggs reached the stage of about a day or two before they were due to hatch we moved them from the cages to transportation cans, two quarts of eggs to the can, the wardens came in with their flivvers and loaded up with the cans and cages and distributed the eggs to all the perch lakes in the state. Some of these eggs hatched in the cans on the road. Some of them hatched within twenty-four hours after they were placed in the cages, and it was a very clean hatch.

If we had left these eggs on the tops of those willow trees they would have been suspended in the air anywhere from four to sixteen feet and would have been removed by large flocks of blackbirds. It was a kind of conservation that appealed to me as being good, and was very popular among the anglers who wanted these lakes restocked with perch. There

was no question as to the result. I was told that within a week there were great schools of these perch in the lakes to which we transferred the eggs. Perhaps that will suggest some line of thought for you. Perhaps you are doing conservation work of that kind with some other species of fish and can give us some suggestions that will help us to do more of it. My opinion is that we could go along the Connecticut River and do just as much in the other bays as we did in this one. Instead of hatching perch in jars with expensive equipment we can merely transfer the cages with the cans of eggs just at the stage when they hatch off, and in that way have our lakes teeming with young perch.

DR. EMMELINE MOORE: Have you a lake that is not already stocked with perch that you could use as a check and thus find out how well these artificially hatched perch do under natural conditions?

MR. TITCOMB: Well, I could take one of the reservoirs.

DR. EMMELINE MOORE: I should think it would be worth while to get some data on that. How long were they suspended in the air before you got them?

MR. TITCOMB: We kept a boat going around day after day and as the water receded we followed it down. We were collecting for two weeks. The perch kept spawning as the water receded, so that we would have these different strata of eggs on the trees. But the ones that we first took would have been sixteen feet in the air when the water was down on the level. There is no doubt that in any stream inhabited by perch where you have these torrential conditions in the spring of the year you are losing a lot of perch in this same way. The method I have described is a simple and inexpensive way of producing a lot of fry and stocking a number of different lakes.

MR. HAYFORD: Mr. Titcomb has brought out a very good point in regard to the perch spawning. In our state the largest lake is only nine miles long but it has fifty-three miles of shore line that is dotted with coves. The perch in some sections do not use their judgment at all in spawning; they spawn almost anywhere, sometimes in places where the waves are considerable and the eggs become buried some inches—there are no trees they can use there. I have picked up in the length of an ordinary eighteen foot boat about nine million of these eggs, with an ordinary dip net; they are piled in there perhaps two feet deep, down in three or four feet of water. To me it is one of the greatest things anybody can do—to conserve these eggs, because you can put them in the lakes even among the rocks where they are protected in the shallow areas, and they will hatch out. There are quite a few lakes where these conditions prevail. We cannot handle them all, but the perch are becoming a popular fish.

MR. FOSTER: A word about the popularity of perch in Arizona. I was at Norman Lake a couple of weeks ago, and they are catching exceptionally large perch in great numbers there. It is only a matter of a few years since the stocking was made. I saw a string of perch from nine

to fifteen inches, some of them weighing two pounds and a half. The people there are wild about the perch. Did I understand Mr. Titcomb to say that he did not get good results from the transfer of eggs from the Missisquoi?

MR. TITCOMB: No, we didn't that time, but I would now. We should have suspended the eggs in cages until they were ready to hatch off; then we could move them.

MR. FOSTER: We moved rescued eggs from the Potomac to Missouri. They were green eggs and the eye spots were beginning to show by the time they arrived in Missouri. We got a good hatch from those.

MR. TITCOMB: I have no doubt we could get them at all stages. This was entirely experimental work by two new men. I think there is a chance for the Bureau to collect five hundred million eggs up there every year.

MR. LEACH: We tried that same scheme around Lake Champlain. We did the same as Mr. Titcomb did—sent men out and collected eggs off the bushes and from the hanging grass, and so on, brought them to the hatcheries and hatched them out. But the eggs were in various stages of development and we could not tell just how far along they were, so we were not successful in shipping them. At Bryant's Point, near Mount Vernon it had been the practice to take the eggs out in the morning with dip nets and then put them in wire cages of which Mr. Titcomb has spoken. They are about twenty-four inches long and eight inches in diameter, cylindrical in type. The eggs are held in these baskets, suspended in the water, and allowed to hatch. When I went to Washington first I was doubtful about the results that might be obtained in this way, so I hatched some out in order to try it. We found that the eggs hatched out in these baskets much better than they would in the ordinary glass hatching jar, and we got very good results. I felt sure that the eggs which would hatch in the river in that way would hatch in a basket with much better result where they were protected from their enemies. We have employed that system at several of our stations and we find that it works very satisfactorily. It also saves a great deal of trouble, because the ordinary hatching jar which will hold three and a half to four quarts of whitefish eggs will not hold more than a quart of yellow perch eggs. It is a simple matter to handle a large number of eggs in these suspended baskets and to do so with very little difficulty.

MR. FOSTER: We have had considerable experience in connection with the transfer of eggs from Washington to Neosho. But the eggs we have shipped have always been eggs of which we had knowledge of the time of their being deposited by the fish. I doubt very much whether we would be able to go out into the streams and take the eggs off the bushes and ship them with any success. Almost all our eggs that are shipped between stations now are sent in ordinary transportation cans

and we aerate them just the same as we would the fish. In that way they are handled very successfully.

MR. LEACH: You are shipping eyed eggs, which is a different story.

MR. TITCOMB: You can go to the Missisquoi Bay, pick up five hundred million eggs, put them in these trays on a raft close to the surface, have your man inspect each basket every day, and when the eggs get eyed, ship them.

MR. LEACH: But you cannot go out there, pick them up, and then ship them, because we tried it.

MR. TITCOMB: No, we made a failure of that, but with the knowledge and experience we have now I think it is absolutely possible to do it with eyed eggs.

MR. LAIRD: Speaking about conservation, we have had two men out all summer with rifles and they have shot five thousand pickerel. I think that is some conservation. These are the small pond pickerel with the red fin. They never grow more than twelve inches long and are useless for sport. They are edible, but they are not big enough for anybody to be bothered catching them.

MR. TITCOMB: The hatchery of which I have shown you the floor plan is quite a luxurious plant, and the ordinary commercial breeder probably would not build such a plant. But we do not confine all our work to luxurious plants or show places. You can hatch fish in almost any kind of place you can prevent from freezing. In our various activities we use canvas for work which does not call for looking after the eggs through the winter. For example I imported five million pike perch eggs from a hatchery in Vermont, put up the trough with spigots in it, set the hatching jars in the trough under the canvas, hatched those eggs right there and then distributed them in a lake where I wanted to make a thorough experiment in the introduction of pike perch. We also use canvas and some portable equipment all of which may be carried on an ordinary truck, in the hatching of shad and smelt eggs. We had two of these little portable hatcheries down on the shore near the Sound, where we collected eggs of the smelt from the fish which were destined to market. We set the jars up under canvas—in one case they were not even covered—and we distribute the progeny in various tributaries along the Sound in an effort to bring back the smelt fisheries, and transfer them all to lakes.

This hatchery where we have the very convenient floor plan, with shower bath for the men and all other conveniences, is going to be in the rough outside. We won't have any lawn mowers; you can go out there in the spring of the year and you will see the laurel growing everywhere. The idea is to keep the place as close to nature as possible and to have as little work as possible outside of the actual fish culture. There will be a parking place for cars, but the rest of it will be as wild as it was when we came there.

MR. FOSTER: On the question of lawn mowing, I think we have as many visitors at Neosho as they have at any hatchery in the United States. Sometimes we have five hundred on the grounds at one time. So that we have to keep the lawns cut and the grounds in an attractive condition, and we get a whole lot of compliments on the appearance of the place. Of course that is operating a public park and getting away from fish culture, but to some extent you may have to do it in order to interest the public.

MR. LEACH: All our hatcheries are in rather prominent places, and on account of them being government institutions the local people take a great deal of pride in the grounds and buildings. It is therefore necessary for us to maintain them in more or less of a park condition. That costs us quite a little money and it does not help us produce any additional fish. At Washington a few years ago we got a lease on some bass ponds. They are right out in the colored settlement, about seventy acres of them altogether, twenty-eight acres under water at the present time. These ponds are, you might say, in the wilds. The weeds grow up all around, and we make no pretence at growing lawns, even at cutting the weeds. We have out there one colored fellow at \$45 a month to look after the ponds, and we have been able to produce more bass per acre at that place than we have been able to produce at our stations where we were spending five or six times as much money. They have a high-class personnel at the stations, and everybody is working. Of course it is necessary to maintain the stations up to a certain standard because they are government institutions. Out there it is rough country, nobody is particularly interested in the place, and the production of bass is exceedingly good. I believe that is the way to produce bass—raise them under natural conditions. That is where you can get results. When you come down to this intensive system of producing bass at stations where you have nice lawns, shade trees, and so on, you cannot get the results that you can with large ponds of fifty to a hundred acres where you can control the water supply, turn the fish in there in the spring of the year, give them no attention except to protect them from birds and predatory animals, draw down the ponds in the fall and take out the fingerlings. It is better to do that than to try to get by on numbers rather than quality.

MR. TITCOMB: I learned this morning, Mr. President, that some of those who heard me tell about the rescue of perch eggs yesterday thought that we picked them out of the tops of the trees because I said we used an apple picker as the implement for getting the eggs. Now the water recedes a foot in twenty-four hours. In order to gather these eggs successfully you must get them before they are exposed. You start around with a boat and go over the same spawning grounds every day

during the two weeks that the fish are spawning. You may see perhaps an inch of the string above the surface of the water; that will be an indication that there are other strings under the water. If the water is too roily to see them you can get hold of the bushes, pull them towards you and thus expose the eggs. The apple picker is used with a comparatively short handle. The claw wires of the apple picker seems to be just about right if you line the inside with a fine wire mesh. But we do not wait until the perch eggs are suspended sixteen feet in the air before we attempt to collect them.

PRESIDENT COBB: Mr. James P. Brooks who is assistant Superintendent of Glacier National Park, is not here, but his paper will be read by Mr. Roger N. Toll, Superintendent of the National Park Service, who will give an illustrated talk on "Our National Parks."

MR. TOLL: Mr. Brooks expressed great regret at not being able to be here, both because he would have enjoyed the personal contacts and because he would have had an opportunity of hearing the proceedings of the Convention and the discussion of subjects in which he is interested.

INTRODUCTION OF TROUT AND THE PLANTING OF EYED EGGS IN REMOTE AND ISOLATED WATERS OF GLACIER NATIONAL PARK.

BY JAMES P. BROOKS,

Assistant Superintendent, Glacier National Park.

The introduction of different species of trout fry in Glacier Park was begun in the early history of the Park, shortly after its creation about 1914. The waters then planted were the most accessible and the quantity of fish was small, owing to the bad roads and the small amount of fry obtainable at that time. The success attained from these initial plants as evidenced by the rapid and prolific growth of the different species was remarkable. In fact the early visitors to Glacier Park were amazed at the quantity and size of the trout from these waters.

In 1921, my first year in Glacier, I made an extended trip, visiting most of the lakes and streams in the Park. At that time there were many lakes and streams barren of fish. I was deeply impressed with the possibilities of these virgin waters, if they could be stocked with trout. I was confronted with the problem of getting the fry into these almost inaccessible places. Some could be reached with pack horses, but in many cases, this method was useless as there were no trails within many miles of them. It would be a comparatively easy task to stock the lakes to which pack horses could be taken; but to plant the wilderness waters, the usual methods were not feasible.

THE PLANTING OF EYED EGGS.

I brought this problem to the attention of Mr. W. T. Thompson, Superintendent of the U. S. Fisheries Station at Bozeman, Montana. Mr. Thompson suggested the introduction of eyed eggs to waters inaccessible to pack horses. In July, 1922, Mr. Thompson and our rangers made the initial plant of black spotted (red throat) trout eggs, planting about one million. The method used was as follows: Eyed eggs were received at Glacier Park from the Yellowstone hatchery, transferred to small cases suitable for horse packing, and taken by auto truck to various distributing centers. From here they were taken by pack horses to the ends of trails nearest the waters for which they were intended. Here they were transferred to still smaller

packs and carried in on the backs of the men. This was not always an easy problem. Many difficulties were encountered by our workers. Icing the cases to retard the development of the eggs was a prime essential. Carrying this ice was a problem but this was overcome by carrying extra pack loads of ice. Dense alder thickets and jungles had to be penetrated. The packs, weighing from forty to sixty pounds soon became a burden to the toiling men. Now and again a quarrelsome grizzly questioned our right of way through his huckleberry patch. These were only a few of the difficulties encountered. But in every instance the zeal of our force prevailed and the eggs were planted.

In planting the eggs we tried to select gravelly beaches or bars to simulate as nearly as possible the natural spawning conditions of the fish. Scooping out a small amount of gravel in from one to three feet of water, we placed about five hundred eggs in this depression. These eggs were then covered with coarse gravel to a depth varying from one to three inches. In flowing streams we used a "V" shaped board to retard the flow of water while we were depositing and covering the eggs. In some instances, where gravel was lacking or unsuited to our purpose we planted the eggs without covering them, selecting shaded places in rocky clefts along the lake shore.

We were all keenly interested in learning what the results would be from this method of planting. We checked carefully on the barren lakes each year. In 1923 we were still unable to determine if our plants were successful. But in 1924 our observations proved that the eyed-egg planting was a success. In that year schools of fish estimated to be about eight inches long were seen by the rangers.

This method of planting in remote and inaccessible waters has enabled us, in Glacier Park, to stock eight or more streams and about twelve lakes that otherwise would still be barren. These waters are now well stocked with fish awaiting the skill of the zealous angler.

Since the inauguration of this method of fish planting we have developed our system until now, with improved man packs and egg cases, we can reach any body of water, no matter how distant or difficult the way. In all, about two million black spotted trout eggs have been planted during the last four years. I believe that other species could be handled in a similar manner. But it was our intention to concentrate on the black spotted trout for our remote waters and plant this species only.

We all feel that the success of this venture is due to Mr.

W. T. Thompson, who sponsored the idea. Without his valuable assistance and co-operation we could not have attained the results of which we are all justly proud.

FRY PLANTING.

Undoubtedly, all of you are familiar with the methods of planting fry. And yet, I feel that it would interest you if I touch briefly on fry planting in Glacier Park. A hatchery is maintained and operated during the summer months, hatching most of the fry planted in the Park. We also receive many shipments from the state of Montana and from the Federal hatchery at Bozeman, Montana.

Let me illustrate our method of handling large quantities of fry. Just recently a U. S. Fisheries car arrived at Glacier Park with two hundred cans or about one hundred thousand large brook trout fingerlings. Ten trucks were waiting at the stations and the cans were transferred to them. These trucks carried the cans of fish to the waiting pack strings many miles away. Four pack strings, of ten horses each, were used. The area covered in this plant alone, ranged from Glacier Park Station to the international boundary line and Canada. Eight to ten lakes and streams were planted. The fish car arrived at Glacier Park at five o'clock A. M. and by ten o'clock A. M. the car was entirely unloaded. Some of the assignments were taken by truck over one hundred miles and from there packed at least twenty miles to their destination. Some passed through Canada to reach our remote northern waters, traveling by truck, boat and pack string a distance of about one hundred and forty miles. In all, our losses were far less than one per cent, or practically nil. In handling the fry for northern waters, we have received splendid co-operation from the adjoining Canadian Park,—Waterton Lakes Park.

We find that ice is essential in handling fry and fingerlings. Extra pack loads of ice are carried when packs are made into distant places. Screened-in troughs are often used when fry have to be kept over night in transit. These are placed in flowing streams. In some of our plants, where two or three days are required, we have found these troughs of great value.

It is not unusual for anglers to catch trout weighing from five to eight pounds, especially cut-throat, rainbow and brook trout. This indicates that there is an abundance of natural food in our waters, but not being satisfied, we have introduced aquatic vegetation and fish food in many of the smaller lakes high up in the mountains where it appeared to us that there might be a scarcity of food as the number of fish increased.

Each year a heavier toll is levied on our fish. The increasing number of tourists to our Park means that we must expand our activities although this year we planted two million fry and eggs, it was entirely insufficient to supply our needs. When the development of the Glacier Park road system is complete, it will mean double the present number of tourists. To keep pace with these anglers' activities, we must be prepared to carry on a greater expansion in all lines of fish cultural activity.

Discussion.

MR. THOMPSON: I would like to say a few words in connection with this most interesting paper, as I had the privilege of co-operating with Mr. Brooks. Few of us realize the effort that has been made on the part of the National Park Service and especially of Mr. Brooks to cater to the angler of the future. The lakes and streams referred to were very distant; there was no convenient means of access, yet Mr. Brooks and the National Park Service coveted them for the angler of the future.

The lakes of Glacier Park are of a different type from any others in the United States. It is a glacial region and the lakes are alpine in character. There is absolutely no shore vegetation and you have to go to a depth of six, eight or ten feet before you find any vegetation. Its absence suggested an inadequate food supply and we requested the Federal Bureau of Fisheries to make a scientific investigation in order to determine whether sufficient food was present and, if not, what means could be taken to increase the quantity. In the meantime, we proceeded to improve it in a practical businesslike way. From Lake Ronan, Flat-head Lake, and a number of others, we secured a quantity of aquatic life and vegetation, aquatic insects, plants, etc., and planted several hundred cans, while we were awaiting scientific aid. This year we received the services of several scientists among them one particularly well known to members of this society, Dr. Henry B. Ward, scientific adviser to the Bureau of Fisheries, head of the Department of Zoology in the University of Illinois, and a former President of this society. He requested me, by the way, to convey to the society his regrets that he could not be with you. But I assure you he is doing a greater work in Glacier Park than he could possibly be doing here. The investigators are finding that the plankton and other food are present in considerable quantities in the depths of these lakes. Dr. R. A. Muttikoski, formerly connected with the University of Idaho, now with the University of Detroit, and his assistant are making intensive studies of the food fish.

The following incident serves to illustrate the peculiar character of the lakes. On one occasion when traveling with Dr. Ward and Mr. Leach, Chief of our division of fish culture, we topped the Cut Bank Pass over the Continental Divide. Right down below was a little lake of prob-

ably five or six acres. It had no inlet except the melting snow from the mountain pass and no outlet whatever. As we looked down on it we could not see any sign of fish. The Assistant Chief Ranger said that the previous year he had caught some splendid trout which had been introduced in 1921 or 1922 and that he wanted to show us the quality of these fish. We thought that he was joking until he returned in a short time with six wonderful trout. Two were females which were just ready to begin spawning. The other four were females which apparently had not spawned this year and did not appear quite sexually mature. They were hard as rock, and when we cut through the flesh, it was not like cutting through ordinary fish, but more like cutting through beefsteak. The six fish averaged three-quarters of a pound each. They were probably planted in 1921 so that they would be four years of age. This growth is not phenomenal but it shows that the highest of our Alpine lakes, right on the crest of the mountains can give good results. In these Alpine waters the season is probably not over four or five months long so that the growth is not as great as in the more southern lakes, but the quality of the fish is superb especially at this time of the year.

These Alpine lakes in the National Parks are going to be the fish refuges for all time. It is fortunate that in places where there is no possibility of contamination or devastation, and where the climatic conditions are such as to impart an unparalleled vigor to our fish, these refuges are to remain forever. From time to time it will be necessary for the commercial hatcheries to have recourse to the wild fish from these waters to renew the vitality of their stock. In this respect I believe that the national parks are going to do a wonderful amount of good for the future of fish culture.

OUR NATIONAL PARKS

Mr. Roger W. Toll gave an illustrated talk on "Our National Parks," which was not reported.

TROUT FISHING IN THE NATIONAL FORESTS

BY JOHN H. HATTON,

Assistant District Forester at Denver, Colorado; in Charge of Live Stock and Game Administration in the National Forests of the Rocky Mountain District.

The National Forests of the western United States contain in pretty large measure the waters supporting or capable of supporting trout of the various species. We get something of a conception of the scope and importance of this resource and of its possibilities when we try to visualize some 150,000,000 acres of mountain lands with their numerous natural streams and lakes, to which may be added many artificial bodies of water suitable for this class of game fish. Colorado alone boasts of 6,000 miles of trout streams, and supplementary to these are many ponds and lakes admirably adapted to the propagation of trout.

I have not at hand accurate figures on miles and acreages of water in all the National Forests of the West, but roughly, and in keeping with our present day statistical method of expression, the trout stream possibilities, using Colorado as a comparison, would be in round figures 70,000 miles in the National Forests of the West. This is not to mention the aggregate extension of many of these streams by many thousands of miles into areas outside the forest boundaries. Expressed by the Colorado slogan of "A trout for every foot of stream," these waters would support fully 400,000,000 edible fish besides the smaller growing stock, which I am sure you will agree is not an impossible objective or slogan for at least the larger of our mountain streams, and one that is doubtless realized in many of them at the present time. I am sure it is realized in one Wyoming stream that came under my observation a few days ago.

We can express in cold figures the value of fish as a food but we cannot evaluate the pastime of fishing to the life of the nation. It would be like attempting to place an intrinsic value on recreation in the Yellowstone or in any of our National Parks or National Forest playgrounds. To estimate, much less calculate, the value of the outdoors in health and happiness and renewed human efficiency to the people of this nation who are yearly and increasingly planning and budgeting a certain amount of outdoor recreation in the mountains, away from the heat and grind of the cities or the everyday routine of rural occupations, would be futile. A recent editorial in the

Saturday Evening Post points out so well the tendency of our present day recreation, the form it is taking, and its cost in money to the participants, that I want to mention here a few of the figures and conclusions as bearing somewhat on the subject of this paper. The editorial states that \$2,500,000,000 will be spent this year by motor campers and automobile tourists. Not millions, but billions! These figures, stupendous as they are, do not include the cost of cars that will be used, and the International Chamber of Commerce at Brussels has stated that we have seventeen and a half million cars in use. In 1924 no fewer than 12,000,000 persons went in for real motor camping and slept in their own tents or cars at night. The total for 1925 will be greater. They spent last year no less than four hundred and fifty million dollars for camp equipment alone. More than 6 millions of the 12 millions make trips of over a thousand miles and spend not less than 33 days under canvas. The daily expense of the 12,000,000 will run very close to \$2.05 per person, or \$7.17 for the party of the average size. Incredible as it may seem, if our motorists increased their expenditures by less than fifty per cent their outlay would equal the entire amount that it cost to run the United States Government and all its various activities during the fiscal year just closed.

Not the least of the attractions that are drawing folks to the mountain playgrounds is the lure of our mountain trout. If we wish to make the maximum contribution to the more intangible benefits I have mentioned in the life of our people and the nation, we need to take complete stock of the present condition of our trout streams and to visualize to the full their possibilities and our opportunities.

I need not say to you that the Forest Service, to which has been entrusted the protection, conservation and use of the other resources within the National Forests, is intensely interested in helping the states to foster and increase the fishing resource. I believe along with the other resources such as timber for wood uses and forage for live stock, it appreciates to the full the importance of fostering the products of our mountain waters. The Service stands ready to aid and is aiding as far as practicable through assisting in the prevention of law violations, through close observation and studies, through comprehensive reports based on first-hand information, and co-operation with federal and state and local agencies, through systematic requisitions for fry and through the actual planting of many millions of fish by our field men, who, I may say, are carefully trained in fish planting requirements.

As indicative of the work that is being done by the Forest Service in the various National Forest States, I might mention the accomplishments of the past few years in the 27,000,000 acres of forest administered from the Denver office of the service. I regret that due to my absence in the field, I have not had time to obtain data and prepare an accurate statement for the entire service. I should state that the heavy demands upon the state and federal hatcheries by citizens and local clubs, which demand appears to be yearly growing, have made it impossible to allot to the Forest Service the numbers usually requisitioned and which it has been in a position to take care of. I may state also that beginning in 1914 in this district we prepared a comprehensive long-term plan of fish planting which has been carried out as consistently as possible. This plan for the period 1914-1922 provided for plants aggregating 20,046,500 trout fry from federal hatcheries alone in the waters of the Colorado National Forests and those of Wyoming, exclusive of the Teton country. The federal bureau approved the plan and furnished fish to the extent of its possibilities in view of other demands. For the first few years it was unable to furnish more than about 50 per cent of the fish requisitioned, but since our requisitions were much heavier at first a very creditable average showing was made for the entire period. For instance, in 1917 our plan called for 2,292,000 fish, and 2,962,000 were actually requisitioned and 1,547,700 received from federal hatcheries. But 2,129,000 were received from the state hatcheries that year, making an aggregate planting by forest officers of 3,670,700. In 1916 a total of 4,220,490 were planted from both the state and federal hatcheries. With the aid of the states we have been able to fulfil very well and even exceed the comprehensive plans prepared in 1914. But no plans, however comprehensive, have been able to keep pace with the increasingly heavy drains on the fish resources.

The extensive travel throughout the West I have just related is taxing to the utmost the resources of the states and of the Federal Bureau of Fisheries to meet the demands for fish for stocking purposes.

In round numbers, forest officers on the 27,000,000 acres of forests covered by the Denver district have planted during the ten year period closing with 1924 approximately 45,000,000 fish for stocking purposes. Assuming that other districts have done as well according to acreages, and very uniform programs have been inaugurated throughout the service, the Forest Service in this ten year period has assisted

the states in this important activity of fish planting to the extent of 2,475,000,000 fry, which I believe is a conservative figure. I may add that formal reports are made by the field men on each separate plant.

So much for the subject of fish planting by the service itself. Of course, it is realized that the independent activity of individuals, clubs, states and other agencies make even these figures, running as high as they do into billions, seem small in comparison. This is particularly true of some of the eastern states. However, they show the interest and the activity of the service in its desire to make its contribution to one of our most important mountain resources and possibilities, keeping in mind, of course, the need for correlating this resource and activity with the various other National Forest resources and activities.

Engaged as many of our men are and have been in contributing to this work, and noting the increasingly heavy drains upon the fishing resource, they have very naturally reached the conclusions which they feel would make for greater effectiveness and improved conditions. While some of these observations may not have the dignity of an absolute basis in biological facts, they come from practical contact with field conditions and are doubtless worthy of our authoritative consideration.

For instance, the question of fish foods, it is believed, should have almost equal attention with fish planting. Many of our waters are naturally supplied with food, many are not, or some are inadequately supplied. I noticed a few days ago, in one of the Wyoming streams, trout planted three seasons ago had reached a size of but six inches. In other places we observe that the heads of fish are disproportionate to the size of their bodies, indicating an insufficient quantity of natural fish food. Each state, we believe, could well employ a fish specialist, biologically trained as well as trained in the practical art of fish culture, who would be qualified to make intensive surveys of our various waters to determine what is needed, or what species of fish is best adapted to them.

The matter of protected state spawning grounds is rightly receiving increasing attention.

The question of retaining ponds has had much thought and considerable attention and in many places no plants are made directly into the swift mountain streams where it is at all feasible to use protected waters until the fish reach the fingerling size. Inexpensive ponds have been constructed in many places for this purpose; beaver ponds have furnished tempo-

rary refuges, and in other places sportsmen's associations have matched state funds in the building of more expensive retaining ponds. There are opportunities for greatly extending this work with much saving of loss in original plants. A full survey of these possibilities should be recorded and used. Such a survey was attempted by the Forest Service in co-operation with the sportmen's associations of Colorado a couple of years ago.

The ever present question of a practical fish screen to prevent losses in irrigation ditches is still with us and needs the fuller consideration of many states. There should be more authority in various states to close streams or portions of streams to protect small and growing fish. The alternate closing and opening of waters in the same vicinity has been suggested, or the closing of headwaters, on the theory that fish will go down stream to deeper water when they attain a larger size.

Apparently there should be more attention given to reserving special waters for particular species. Different state departments should doubtless get together on uniform laws and policies where inter-boundary conditions are similar. Seemingly there should be more uniform legislation establishing a size limit on trout, possibly making the minimum eight inches, and trout fishing should be prohibited during the spawning season. Where practical the fishing season should be made more specific for the different species of trout and should close at least thirty days in advance of the spawning period and not open again until thirty days after the completion of spawning. In short, every practical means should be adopted to reduce to a minimum the losses from artificial and natural propagation if we are going to keep pace with the growing drains that are yearly being made upon the mountain streams. Certainly the extension of hatcheries and the production of greatly increased numbers of fry for stocking purposes will never in themselves take care of this rapidly growing problem.

We need more literature based on authentic observations of fish and other wild life. Some states excel in this respect. Others are content to limit their publications and literature to the biennial reports required by their state legislatures. The public should have authentic, accessible information of what is being done and of the needs and possibilities. The opportunities for thus strengthening the hands of state officials is exceptional, it seems to me, and all possible use should be made of this form of education to build up a nationwide

interest in our various forms of wild life. Every state could profitably maintain, we believe, a department of public information, with perhaps a central—call it national—informational agency to put out educational material for the country as a whole.

Then there is the problem of increased private control of the fishing waters, and the exclusion of the public from them. It is a pretty delicate subject, but some practical way should be devised, if possible, to meet it. Legislative attempts in this direction out here have so far failed. Possibly the approach should be made through land-owners themselves. The Forest Service has adopted a policy of safeguarding the remaining open waters in the forests to the general public, but these are now all too inadequate to provide this form of recreation to the growing numbers who find pleasure and benefit in the pastime of fishing.

In conclusion, it seems to me that one of the most encouraging signs of the present is the increasing interest the public is taking in game and fish questions through local and state sportsmen's associations. People generally are thus getting into a better position to inform themselves and take a personal interest. The association together of communities for this purpose will bring immense returns in better respect for laws, in looking beyond our front or back doors, in seeing things from the other fellow's viewpoint and needs as well as our own, and in making for beneficial changes in protective and conservative legislation. State departments alone cannot meet the situation, however efficient they in themselves may be. They must have the active, intelligent, wideawake, co-operative and constructive interest of the individual and general public in all that such a statement implies.

And lastly, the subject of wild life in the states and its administration should be divorced absolutely from political considerations. Most state officers, I believe, would welcome this condition and are honestly attempting to accomplish it, but they need the whole-hearted help of the public through their legislative bodies.

MR. AVERY: I think it is a great privilege that we have had an opportunity to listen to these excellent addresses from representatives of the National Forest Service and the United States Park Service. It is an indication that the various branches of the Federal Government are desirous of co-operating with the work of this society, and in recognition of their participation in this meeting and the contribution they have made to our records at this time, I move, Mr. President, that

we extend to Mr. Hatton and Mr. Toll a rising vote of thanks.

(The motion was carried unanimously and Mr. Hatton and Mr. Toll were accorded a rising vote of thanks.)

MR. BURNHAM: There is one problem in connection with the fisheries of Canada which has interested me as a sportsman and fisherman, and I would like, if it is agreeable, to get information from Mr. Harkin on the subject. In the Yukon watershed there are practically no trout. The whole watershed is full of grayling. One species of large trout, salmon trout, is found in the extreme upper part of the Yukon River, and in possibly other streams and some of the lakes. Here is one of the biggest watersheds in the north where all the tributaries are ideal trout waters but where trout are practically absent. It has always seemed to me that the fish hatcheries of the Dominion should stock these splendid trout waters after, of course, a proper amount of preliminary investigation to determine the biological conditions and decide as to the advisability in each instance of perhaps superseding grayling with trout. On several occasions I have taken that matter up with various Canadians, some of them in official positions. For example, I talked with the Superintendent of the Banff Hatchery, I think in 1920 in regard to it. But it would seem to me a very desirable thing, if it could reasonably be done, to add suitable varieties of square-tail trout to these splendid northern waters, probably the largest area in North America of suitable trout waters not now inhabited by trout. Of course this is somewhat out of Mr. Harkin's province, but as we have him here I should like to ask if anything could be done along this line.

MR. HARKIN: As Mr. Burnham has just said, this is entirely out of my line; the work I am concerned in is that of the national parks and wild life. I regret that there is no representative of the Canadian federal fisheries service here; usually representatives do attend these meetings. I can say nothing about the Yukon conditions. I agree with Mr. Burnham: it seems unfortunate that we have not proper kinds of fish there. All I can say is that I shall be very glad to bring Mr. Burnham's remarks to the attention of the Federal Fisheries Department when I return to Ottawa, and I have no doubt that they will look into the matter. Many of you know the officers who have to do with that work, and I think that you will agree they are very enthusiastic in regard to it.

SOME OBSERVATIONS ON FISH CULTURE.

D. C. BOOTH.

In all ages and with every race fish have been important factors. They are among the oldest vertebrate forms of animal life and antedate recorded history. No doubt they were the subject of many interesting discussions in early times and it is not improbable that future excavations may yet reveal the proceedings of some ancient fisheries society. It will be highly interesting if such discoveries are found for we may then ascertain not only the point of view of our ancient brethren but possibly hear a new fish story. We are told that fish was the symbol of the early Church and that its leaders were fishermen. No form of animal life has entered more intimately into the various activities of the human race than fish. They have been the subject of serious discussion by states and nations and have served as the basis for international treaties. The small boy starting forth with a sapling, a cotton string and a bent pin and returning with a few minnows has probably experienced all the joys of the millionaire angler with his thousand dollar outfit. It is unnecessary that the boy understand the theory of evolution or whether the minnows on his string are Teleostomi or Echinodermata in order to fully participate in the joyous hours of outdoor America. During the early days of fish culture the primary inquiries were scientific while the results were practical, and this condition prevails at present. The present day superintendent of a modern fisheries station should be a past master of a number of trades, have a working knowledge of several professions and be an all around office man in addition to a thorough knowledge of fish culture. The stocking of waters previously without game trout is a credit to American fish culture and probably the most conspicuous examples or illustrations are Yellowstone National Park and the Black Hills of South Dakota. This refers to the entire Black Hills and to Yellowstone National Park outside of the Yellowstone Basin.

The presence of suitable forms of small animal life in the waters is a determining factor in the quantity and quality of the fish life. Probably one of the most prolific as well as desirable forms of small animal life suitable for game

trout found in our western waters is the *Gammarus pulex* commonly known as the fresh water shrimp. The shrimp are hardy and have been shipped long distances by parcel post with excellent results. They will also adapt themselves to new environment and thrive if the conditions are any way favorable. The waters in the western states in which game trout are found usually have a considerable supply of shrimp and their introduction into other waters would seem advisable. Some of the smaller members of the fish family, undesirable and of no particular value except as food for game trout, might also be introduced with good results.

Too many small trout are planted in the main streams and too few in the headwaters and small spring tributaries. The planting of trout fry is no longer considered good fish cultural policy although there are some exceptions. The headwaters of some very desirable trout streams are inaccessible for trout and very difficult for any man to reach. In such places it is often advisable to plant either the well developed egg or small fry. A plant of this kind made some twenty years ago in one of the smaller lakes of Yellowstone National Park produced wonderful results. No trout or other kinds of fish had ever been seen in this lake previous to the planting of the eggs and fry and the conditions seemed very favorable. One year later thousands of ten inch trout were seen trying to ascend the small snow fed tributary stream. The trout were so plentiful and of such high quality that the Yellowstone Park Association placed a row boat on the lake and employed a fisherman a portion of each day to catch trout for the several park hotels.

Many years ago an effort was made to produce through selective breeding a superior type of trout with the characteristic form and markings of a perfect fish. It is understood that this method has been practised for a long period in Japan. The usual fish cultural station is not an ideal place in which to carry along experiments. In order to obtain accurate results and nothing short of accuracy is of value in any experimental work, all material must be under complete control. Such a condition would be somewhat unusual at a fisheries station. A good depth of water is very desirable in a pond used for trout, especially if the fish are large and the temperature somewhat high on the surface. Experience has shown that eight and ten inch trout will thrive and do well in a pond of moderate depth

with a water temperature above 65 degrees F., while twelve inch trout under the same conditions would perish. This of course implies a considerable volume of pure water constantly flowing through the pond. If every fish cultural station could have an abundance of pure, cold, mountain spring water not only for the hatchery building but also for the ponds conditions would seem ideal.

It is not possible however to always have ideal conditions and a certain fish cultural station was successfully operated with less than twenty three gallons of spring water per minute available for the hatchery building. With fifty-two hatching troughs in use this did not leave a very large volume of water per trough. It was of course necessary to have someone on duty at all times during the day and night. This record merely shows what can be done in an emergency and under adverse conditions. However it is not recommended as the margin of safety is too small. The propagation and distribution of any species of fish is largely a matter of dollars, since with sufficient funds available one could operate a successful fish cultural station on the top of Pikes Peak.

The so-called commercial fishes are important solely for their financial and food value. It is possible to obtain an equivalent in wealth and food in other ways so that the commercial fishes are not indispensable. Too much stress, however, cannot be laid on the esthetic and recreational value of the game species, and whoever heard of a man planning a summer vacation catching the commercial fishes? A popular vote in America, excluding certain elements, would probably show a large majority in favor of the game as compared with the commercial fishes.

This age of travel tends to bring a better understanding between neighbors, states and nations. When the other man's point of view is more thoroughly understood there will be less friction and with less friction possibly fewer wars. There is very little politics or religion in the subject of the game trout; it is always a safe topic for discussion which is not true of the commercial fishes. Whenever a man plans a vacation he usually thinks of fishing and when he thinks of fishing he means game trout fishing. A collection of fish stories told around the tourist camp fires would make interesting reading. If one desires a thrill he should attend a meeting of some energetic chapter of the Izaak Walton League of America. He will be astonished at its cosmopolitan membership. Every kind of opinion is

represented and yet all is in harmony for they are talking in that language they all know so well, the language of the game fisherman. There are many organizations, fraternal and otherwise, whose membership is limited by certain requirements but there are no restrictions on membership in the fraternity of game trout fishermen.

Statistics while uninteresting are often valuable. They enable one to determine approximately the number of people who annually visit the Rocky Mountain region including the wonderful Black Hills of South Dakota. There must be some other impelling incentive besides scenery to induce so many people to travel half way across the continent. Travelling implies expense and the tourist hands out some change at frequent intervals from the time he starts until he returns and in the aggregate this runs into millions. In this manner a very large sum of new money is brought in and its expenditure materially assists in the prosperity of the state. Of course those states fortunate in having game trout in abundance profit most still every state through which the tourist travels is benefited by an increased trade. Even the manufacturing states along the eastern seaboard reap their profit in the sales made to tourists traveling through the west. In western Wyoming there are some fifty "dude" ranches. The so-called "dudes" are usually eastern people who willingly pay fifty dollars or more per week for the privilege of living an outdoor life on horse back among the rugged mountains and for a chance to catch game trout. If our western country were without wild game it is doubtful whether its many scenic attractions would attract so many people from a distance.

Wild game, therefore, has its financial side as well as its esthetic features. When both of these are given full consideration it will probably be found that they exceed the commercial fishes in real value. Wild game, already recognized as one of considerable importance, is still largely an undeveloped resource. There are as yet comparatively few places fully equipped for handling the thousands of people who come every season. There are many portions of America at present but little known which have all the natural attractions of the better advertised places. The Big Horn Mountains of western Wyoming with many lakes, some nearly covered with ice in mid-summer, hundreds of acres of snow banks, Cloud Peak towering 13,165 feet above sea level, every lake and stream teeming with game

trout, in its rugged mountain scenery far surpass other places to-day visited by thousands of tourists. That wonderland of natural attractions, the Black Hills of South Dakota, with a higher altitude than any land in America east of the main Rocky Mountain region, with well stocked game trout streams, with fine highways, and majestic mountain scenery will soon become a strong competitor for the summer tourists.

One important feature which should be considered in connection with the exodus of so many people from the cities to the mountains of the west is the eventual pollution of the wonderful trout streams. Already this question has arisen and unless some concerted action is soon taken serious results may follow. Good roads and the auto are responsible for the depletion of the game trout from many of the best trout streams and unless this condition is met by a greatly increased output of fingerling and yearling trout each year, good trout fishing will soon be hard to find. Many sportsmen seem to think that this problem can be met by more fish hatcheries but it would seem that the solution is not in more but in more productive hatcheries. This brings to mind the matter of cooperative fish culture between the various states and the Federal government. Nearly every state at present has a large fund raised by either legislative appropriation or license fees available for the propagation and distribution of game fishes. During the year ended June 30, 1924, New York state alone expended some three million dollars through its Conservation Commission, a considerable proportion of which was for fish and game. Game animals and fish have always been considered the property of the state within which they are found and it is immaterial whether they are propagated by the state or the Federal government. Since these valuable assets are the property of the state it would seem advisable for the state to cooperate with the Federal government in the propagation and distribution of the various species of game trout. Negotiations are now pending and conditions seem favorable for the State of South Dakota to cooperate in this manner with the Federal fisheries station at Spearfish, South Dakota. A fisheries station is in a way a manufacturing plant with certain fixed or overhead charges and every dollar added to the allotment above those stated charges goes toward increasing the annual output.

These attempts are merely the beginning of what may

eventually develop into a far broader field of cooperation between the states and Federal government. Many people are too prone to appeal to Washington for the relief of ills, either real or imaginary, when the solution is all too often a local matter, a situation which is true of fish as well as many other matters. Centralization of activities has many advantages. However some maintain that it already has reached its peak and will soon recede leaving many problems at present under Federal control to the various states.

THE BARBED TROUT OF KANSAS.

J. B. DOZE,

State Game Warden.

In presenting any data relating to the Channel catfishes, it is of importance to inform the reader, for some are not informed, that there are three Channel cats of food importance to North America and but two of these are common to the waters of Kansas. The three known to the Mississippi Valley are the Blue cat or Mississippi cat (*Ictalurus furcatus*), the Channel or Spotted cat (*Ictalurus punctatus*) and the Eel or Willow cat (*Ictalurus anguilla*). The species in which Kansas is more interested is the Channel or Spotted cat, although the Blue or Mississippi cat is common in some Kansas streams. The Willow cat is seldom seen in Kansas.

In thinking of catfishes it is well to divide them in your mind into two classes—the forktails and the squaretails. The forktails are the Channels and the squaretails include the Bullheads and Mud cats or Flatheads.

HOW TO IDENTIFY.

In identifying the two Channel cats that frequent Kansas waters, the safest and quickest method to use is to study the anal fin—that fin underneath nearest the tail or caudal fin. This fin on the Blue or Mississippi cat has a longer base than on the Channel or Spotted cat. It does not extend down from the body as far, not by almost half. The anal fin on the Channel or Spotted cat extends more nearly straight down from the body. That part of the Blue cat from snout to dorsal fin is almost straight. This line arches in the Channel or Spotted cat. The secondary dorsal in the Blue cat is a bit longer and stands up a trifle more than on the Channel.

Another sure way to distinguish one from the other is to look for spots. The Channel cat has spots, always. Sometimes they are very indistinct, owing to the condition of the water, but they are there. The Channel cat does not attain the size of the Blue cat, some of which exceed 100 pounds. The Channel cat of Kansas waters probably does not grow to exceed 15 pounds in weight although in other waters specimens have been known to tip the scales at 25 pounds.

Still another method may be used with some degree of safety, although not always. The Channel or Spotted cat growls about being taken from the water. In rapid and fresh streams they fuss about it so that they have been dubbed "fiddlers." This noise sounds similar to the grating of one's own teeth.

SOME ALERT; SOME DRONES.

Channel catfish must not be judged by any particular specimen. This very gamey and edible fish is capable of being developed into a fighting bundle of tricks when given opportunity. A specimen, taken from a mud-clogged sluggish stream is no more like the fighting, squirming, writhing, leaping, growling rainbow-spotted fish landed from a swiftly flowing, clear, cold stream than is a mud turtle like a lobster.

The reader must bear in mind that in speaking of Channel catfish, the writer is now referring to the Spotted Channel and not the Blue or the Eel cat. It has been said that were Channel catfish known by another name than catfish they would be one of the most popular species of the finny kingdom.

SPINES, CHIEF DISCOUNT.

And while it is not the purpose of this article on the Channel cat to prepare a brief in support of his game qualities, it is well to bear in mind that the Channel cat has nearly all the good habits of any species of fish and fewer bad habits than most. His largest discount has to do with his spines. Three of these spines are barbed daggers, the barbs beginning near the body and placed at frequent intervals to the tip of the spine. One of these vicious spears is at the front of the dorsal fin and the other two are at the front of the pectoral fins. With these he is capable of fighting his way free from almost any hand/hold, for man, once he is stung by one of these barbed spears, is wary ever afterwards.

TRYING TO BREED MULEYS.

The Kansas Fish and Game Department is undertaking an experiment at the State Hatchery, near Pratt, the purpose of which is to attempt to develop a muley Channel cat. Yearlings were dehorned, so to speak, by carefully clip-

ping the barbed spines from the fish near the body. These dehorned fish will be paired off and their offspring given a dehorning treatment in the hope that finally the young will be hornless. While the treatment may not produce the results desired, it may. It would seem, however, that the experiment would offer more chances of producing muley Channel catfish were the treatment directed organically, rather than surgically.

Due to several conditions the culture of Channel catfish has not been encouraged other than in Kansas. It is believed that the Kansas Hatchery is the only one in America producing the Channel catfish for general distribution. Many state fish departments look with disfavor on the Channel cat. This attitude is perhaps more due to lack of knowledge than based upon facts.

CHANNEL MEETS CHANGES.

Kansas has become interested in the Channel cat because it met changing conditions, due to the breaking of the soil and the pollution of the streams by mud, trash, city, factory and barnyard refuse. The Channel cat increased for a time despite these new conditions, taking the places in the streams of the Suckers, Sturgeons, Quillbacks and Wall-eyed Pike. Even the Buffalo gave way to new conditions. These fish, many of them worthless, once were to be found in countless numbers in the fresh, warm-water creeks and rivers of Kansas. They are very scarce now. The Channel cat is perhaps numerically as strong in Kansas to-day as ever, for he has fought his way into streams where he was seldom found forty years ago. This is especially true of the streams of Southwestern Kansas.

The filling of streams from fields subject to erosion due to the plow, destroyed many fine fishing holes, especially the bayous. The Channel cat adapted himself to shallow and warmer water. This brought him to the fore as a possible pond fish.

IT IS A POND FISH, TOO.

Now most fish culturists of a decade ago were positive that the Channel cat could not be propagated in ponds and that to plant the young of this species in ponds was a waste of effort. Not only has this theory been exploded but it has been demonstrated that the Channel cat will thrive in stagnant pools.

SOMEWHAT UNSETTLED IN HABITS.

The Channel cat is neither a bottom nor a top fish. He frequents high- and low-water altitudes, relatively speaking. The angler will find him in deep pools and shallow water. Some days he will shun the deep pools and will seek the shallow stretches. And then on some days there is a wide difference of opinion in Channel catfishdom, for some will be cavorting in rapid water and others lazing the day away in deep pools. Relatively large Channel cat have been taken from shallow water, but a fairly safe fishing rule to follow, if one is seeking the Channel cat, is to try for him near deep water.

SEE, SMELL, FEEL AND HEAR.

The Spotted Channel catfish feels, smells and hears as well it sees in its hunt for food and in avoiding enemies, real or imaginary. They are rapid and strong swimmers. When excited and in shallow water they will dash for deep holes or hiding places in the bank or about islands, swimming so rapidly that it is indeed difficult to identify one. In fact about all one sees is a blue streak. They appear to skim the bottom and are equipped with emergency brakes, for they can stop in a very short space.

EASY TO PROPAGATE IN PONDS.

Contrary to a prevailing belief the Channel catfish is not difficult to propagate in ponds, provided of course the ponds are properly equipped. This species shuns the sunlight in depositing its eggs. It is likely that the eggs of Channel cat will not hatch if exposed to strong sunlight. Our experiments at the Kansas State Fish Hatchery so indicate.

Now the natural breeding waters of the Channel cat are the streams, the swiftly flowing streams being preferred. But the fish does not deposit its eggs in the current. It seeks the deep pools and dens in the banks or caves in the bed of the stream. A rock strewn bottom is often used by the Channel during spawning time.

Therefore it is advisable to equip the breeding ponds, where it is desired to propagate Channel catfish, with artificial dens. Experience has shown that the fish prefer dens near a current of water. For instance, dens near the intakes in Channel catfish ponds at the Kansas Hatchery, were used by adults in preference to others.

A TYPICAL CHANNEL POND.

We use kegs at the Kansas Hatchery because of their convenience in handling. A description of one of the ponds used for the propagation of catfish will answer very satisfactorily as a description for all.

This particular pond is rectangular. Its longest dimension is east and west. Water is fed into it from a pipe line at the northwest corner and from a distributor or flood gate from the west bank near the center. The pond slopes to a ditch extending from the northwest corner to a point near the southeast corner. There is an outlet or drain near the southeast corner, probably a third of the distance north of the south end of the east bank. Along the south shore is a low semimarshy flat, probably fifteen feet wide in its widest place. The water in this flat runs from a feather edge to knee deep. Considerable grass and a few flags grow in this marshy place. The shores of the rest of the pond are more flat, the pitch being a 45° angle, but the slope is far more gradual under the water, being about $33\frac{1}{3}^{\circ}$, and at places even less.

HOW TO PLACE DENS.

Dens have been staked down on all shore lines. These dens are of kegs of different sizes. The kegs are nailed down by stakes, driven one on each side, a wire being placed between the stakes to hold the kegs steady. This wire also holds the keg under water. The kegs are placed at different depths under water in order to suit the different inclinations different fish might have. Some kegs are one foot under water, some more, but none more than two and a half feet. The bank where the keg is placed is scraped out in order to permit the kegs to rest horizontally, the open end being pointed toward deep water. Sand, gravel and some mud are placed inside the keg. The kegs are given a thorough cleansing by using hot steam before being used.

It is desirable to plant fish food and considerable moss in a Channel catfish pond. In the particular pond we are describing, we planted numerous crayfish and the midget fresh-water shrimp, also placing a considerable amount of stoneworts in the pond to attract the dragon and May flies as well as to provide breeding grounds for shrimp and other animal life. The water in the pond we are describing

is turbid. It is perhaps six and a half feet deep at its greatest depth with very little sand in the bottom of the pond.

So much for the pond. Now let's see what happened.

BEGIN TO SPAWN EARLY IN JUNE.

We had the Channel cat ponds prepared in May. About the first of June, sometimes before, owing to the season, the adult fish begin to use the kegs, cleaning them out. We place about twenty-five pairs of Channel cat in a pond such as we described, the area of the pond being three-fourths of an acre. If weather conditions are normal, the Channel cat begin to deposit eggs in these dens June 10, or near that date, sometimes running as late as June 15. A hailstorm or very cold rains will delay them. But immediately after a rain, if the sun comes out brightly, the Channel cat begin to spawn as though they were engaged in competition. We find more eggs in dens on the north shore than elsewhere. Those dens near the intake pipe are used first of all, and generally by the larger fish.

Our fish men visit these dens almost daily after the fish begin to spawn. These frequent visits are made in order to guard against wholesale loss of eggs, through fish eating their own spawn or from turtles, etc., although we have never found a turtle in a den being guarded by an adult Channel catfish. These frequent visits are also made in order to be advised as to what progress is happening, for as soon as the young fish are out of their shell and able to swim about fairly freely, we transplant them to other waters.

MALE PROBABLY DOES THE WORK.

The eggs of a Channel catfish after being deposited in the den, are about the size of a No. 4 shot. Apparently the eggs enlarge during the process of being deposited by the female. They are smaller when taken from the roe, inside of the fish, than when found in the den. We have no definite eye evidence relative to the process of fertilization of these eggs. It is our opinion that the male fish selects a den and also a mate and that he fertilizes the eggs during their deposit and afterwards. We also believe the male drives the female away when she has presented him with a sufficient number of eggs to satisfy him. The Channel catfish eggs are in clusters and in a form resembling somewhat a spawn of frog eggs, only there are no spots on the fish eggs. The eggs

have a tough mucous shell or coating, and adhere to each other much like tapioca particles.

EYED EGGS IN FEW DAYS.

About the second day after the eggs are deposited, the eyes of the fish are fairly well formed and there is a movement inside of the shell. This movement continues in intensity until about the seventh day when the fish breaks through the shell and swims into individual life. The newly hatched fry are "all fish" from the first or second day on, although they stay together very closely and are not very dissimilar in appearance to the same quantity of Channel cat eggs. The fry are almost transparent when first hatched. Their eyes appear to be the biggest part of them. They are born with horns or spines, but these objectionable physical features are very soft and pliable at first, although within a few days they become hard and sharp.

From the time the adult fish cleans out the kegs or dens until the fry are removed, a Channel catfish is on guard constantly. We believe the male does the major portion of the work in looking after the home, the eggs and the young. This may be presumptuous on our part and an injustice to females. We know this, that a Channel catfish, on guard, will fight viciously and sometimes desperately to protect its eggs and its young. Several of our men have been bitten or rather the skin rasped from their fingers in pulling their hand away from an angry Channel cat which closed its serrated lips upon the protruding finger or thumb. The fish on guard, that we examined, were males. On one occasion, our fish men removed a den from the water in order to examine the eggs more carefully and found the fish still in the keg ready for a fight. In this connection, the desirability of using kegs becomes apparent because the eggs or fry will not run out and it is possible to handle the eggs or fry without permitting the sunlight to strike them.

WATER TEMPERATURE.

Channel catfish appear to prefer water of a temperature of between 70 or 80°, although during the last of the spawning season, which extends to the first of July and sometimes later, the water near the surface of the pond attains a much higher temperature. During the spawning season of 1925 we found eggs and handled the fry when the

temperature in the sun ran above 95°. The weather was dry and hot, although the nights were cool. It required from five to seven days for the eggs to hatch and the fry to become sufficiently active to permit handling. We handled some fry within a day after the young fish had broken through the mucous shell of the eggs, while with others we waited four and five days.

As the Channel catfish hatch later than other fish propagated at the Kansas Hatchery (except Blue Gill), extreme care must be taken to safeguard them against the appetites of such fish as Bass, Ring Perch and Green Sunfish. In order to do this we rear the young Channel cat in what we call retaining ponds. These retaining ponds are smaller than what we usually call our brood ponds. Some are round, some square and some rectangular. We do our utmost to keep the water in these pools clear and so they are built with very sandy shores. The water supply comes through brood ponds into which there are large quantities of moss. The intake pipes are screened in order to prevent other fish from drifting into the Channel cat ponds. Our experience has been that a few score of bass or ring perch will consume thousands of fry within a short time.

OTHER FISH DEVOUR THEM.

During the season of 1924, 200 ring perch, which had escaped into a retaining pond where we planted two hatches of Channel cat, ate every Channel cat in this pond. It is also desirable to keep out the minnows, shad and carp which have a way of getting into nearly every pond on the Hatchery, despite many precautions. These undesirable fish eat the food that otherwise would go into the Channel cat.

In moving the Channel cat fry from brood ponds to retaining ponds, our fish men first make a slight disturbance in a semicircle about the dens in order to scare the little fish into the dens or nests. Then they quickly place a fine mesh hand net over the den to prevent the young from escaping. The den is then removed from its fastening and, after pouring off most of the water, the young, with the water remaining in the keg, are poured into large fish cans in which there is a water supply of about the same degree of temperature as that of the water in the ponds. Another method is to move den and all from brood pond to retainer. Although we have done this work, in all kinds of weather, we find the loss in

transplanting the fish is practically none. Some fish will escape from the den and be left in the brood pond. Frequently we have gone back after moving fry from den and secured a considerable number of fry that escaped the first moving process. Some fry escape even the second attempt and are caught when the pond is drained for fall or spring deliveries. The Channel cat that escape and grow up in brood ponds appear to grow faster than those placed in retaining ponds, although the loss among them probably is very much more.

FRY MUST BE FED.

There is sufficient daphne and other minute aquatic life in the water in the brood ponds to start the fry and maintain them for many days. About a week after we plant these fry in the retaining ponds we begin to feed them. We use two methods, one of which is our own invention and unique in the fish world. The other is used in many hatcheries where it is necessary to feed. First feeding is a composition of clam and corn meal. We have quit using raw clam meal alone. Our food now consists of a mixture of clam and corn meal of about equal quantities, which we cook. This porridge is placed in retaining ponds on sand bars and in shallow water. The fish apparently are first attracted by the scent, for they come from all directions. In time, they learn to come by hearing. We have had ponds where a rattle of the bucket would call the fish by the thousands. Care must be taken not to overfeed, for there is always danger of contaminating water.

FEED BY ELECTRICITY.

Our second method of feeding is both unique and desirable in many ways. It is feeding by electricity. We have strung electric wires over the retaining ponds, permitting the wires to sag within six inches of the surface of the water. Sockets are attached just above the water and the small electric bulbs inserted. In this manner, electric lights can be turned on every retaining pond from one control and turned off in the same way.

Kansas is noted for producing many varieties of things. It has an enormous bug crop. The harvest season is generally about the time we begin to harvest our new crops of Channel catfish. There are millions of leaf-hoppers and other insects in the fields during harvest and the cutting of

the grain disturbs them. They seek new quarters. Light attracts them like an ice-cream cone attracts a small boy. They swarm about these lights and the lights being close to the water, many thousands strike the water in their erratic circles about the bright light. The young Channel catfish, although not more than a half inch long, soon learn what is going on and the water for a radius of six or seven inches about the light is a mass of Channel catfish fry, baby fish with mouth wide open and ready to snatch the unlucky bug that hits the water near that open mouth.

We find that Channel catfish fry, fed by electricity, will double the growth of those fed only on aquatic life and on corn and clam meal porridge during the three months we feed them. So successful is this method and so unusual that it has attracted world-wide attention. We first used it in 1923 on a small scale and since then we have had inquiries from all over the world about it. This method undoubtedly could be used with success in feeding other species of fish, especially trout. We are trying it with our crappie, blue gill and bass, but not in ponds where there are adult fish, for obvious reasons.

Under favorable conditions, a Channel catfish is capable of attaining a length of seven inches in five months, provided food and water conditions are favorable. We have distributed Channel catfish that had attained this length during a four months' period. However, the majority of our Channel catfish range in lengths of three to four inches from the time they are hatched until we distribute them in the autumn.

The Channel catfish fingerling is very hardy and not difficult to haul a long distance either in fish cans, trucks or with a fish car. They are very active and difficult to catch with a net if the tank or can is very large. It is also very annoying to handle them because of their sharp spines which hang in the net. We have noticed that where a considerable number are retained in a tank for five days or more they horn each other and begin to perish from fungous growth. Our fish men favor a dip net made of fine screen wire.

HOW FAST DO CHANNEL GROW?

Much uncertainty exists relative to the rate of growth of the Spotted Channel catfish. A study of this question at the Kansas Hatchery and in Kansas streams has revealed

that there is a wide difference in the rate of growth in different waters. Conditions which govern are food, depth, quantity and quality of water and the fish population of waters.

Under ideal conditions (that is in deep streams with an abundance of food supply, which means a stream fairly free from pollution and where the fish population is not dense), a Spotted Channel catfish will grow fully a half pound a year, and in instances specimens have been taken that exceeded this growth. Our observations lead us to believe that the rate of growth the second and third year is faster than during the first year.

While specimens of the Spotted Channel catfish may spawn the second year, it is not until the third year after hatched that they can be depended upon to spawn. If kept in favorable surroundings, they will then have attained a size of between two and three pounds.

The span of life of the Channel probably exceeds that of most scale fishes although this is but a guess. There are Channel catfish in the Kansas Hatchery that have been held for ten years and still appear to be in prime condition and good for many more years. It is not unreasonable to conclude that a fifteen-pound Channel catfish is at least twenty-five years old.

HOW TO DISTINGUISH SEX.

Unless one is more than ordinarily familiar with the Spotted Channel catfish, it is exceedingly difficult to distinguish sex. Many fishermen pride themselves upon being able to distinguish sex, but it is largely a matter of guesswork with them, aided by a layman's familiarity. During spawning time, or immediately before, it is not so difficult, for then color betrays male from female. The female takes on a yellowish tint underneath; the male is much darker at this time—and more slender. This difference is due to the bulk of eggs carried by the female. The reproductive organs of the male are surprisingly small compared to those of some scale fishes and do not become enlarged to any considerable degree immediately before spawning time.

However there is a definite method to apply to distinguish sex. Both sexes have double vents, the one used in reproduction being back of the other. This reproductive vent opens in a flap or probocis which points toward the tail. It is relatively small and inconspicuous. The reproductive vent in

the male is located near the tip end of this proboscis, which is oval in shape. The egg vent in the female is placed about the middle of this proboscis, that is half-way between the tip end and the point where it is attached to the body.

TEN THOUSAND EGGS IN ONE SPAWN.

There is much uncertainty as to the number of eggs in the spawn of an adult spotted Channel catfish. Our investigation at the Kansas Hatchery gives us authority to say that the spawn of a Spotted Channel catfish will run between a possible minimum of 2,500 and a maximum of more than 10,000. We examined the roe taken from a female weighing four pounds. Our fish culturist counted the eggs he was able to place in a cubic-inch container. The container was filled at the count of 500 and therefore it was his decision that a cubic inch of Channel catfish eggs contained 500 individuals. The particular female he examined was carrying approximately 10,500 eggs. It might not be out of line to say that one of the larger Channels could carry 15,000 eggs.

DISEASES OF POND CHANNEL.

Apparently Channel catfish are more prone to contract diseases in ponds or relatively still water than in their natural habitat. This may be due, in part, to the less favorable conditions of ponds. For instance, this fish, in its natural habitat, has opportunity to select its environment with a less degree of restriction. As a rule, the beds of streams contain sharp sand and gravel and there is always a seepage some place where a fish may procure water of mineral and acid content. It stands to reason that a fish has the same intuitive urge to extract from the stream natural remedies for ailments that a dry land beast has when it extracts remedies from herbs.

A disease condition found in one of the brood ponds of the Kansas Fish Hatchery (the brood pond being stocked with sixty channel catfish), is of particular interest. This pond, labelled "seventy-eight," was stocked with thirty pairs of Channel catfish in 1924. The pond is less than an acre in area and is fed through a spillway from a pond of about one foot higher normal water level. The pond above is relatively shallow, ranging in depth from four and a half

feet to a feather edge. It is stocked with Crappie and gets its water supply from a pipe line and also from a battery of ponds above.

THEIR EGGS DISAPPEARED.

Pond number seventy-eight, which is from five and a half feet deep to a feather edge, was almost a failure in so far as production of Channel catfish in 1924 is concerned. It, however, produced a satisfactory amount of Crappie and a few Yellow Perch which drift in. The sixty Channel catfish furnished a number of spawn in 1924 but within a day or so after the eggs were deposited in the dens they disappeared. The fish were taken out of the lake and examined during the fall of 1924 and a number of leeches removed from them. They were returned to the pond and remained in it during the winter.

On June 2, 1925, our fish culturist found a spawn in one of the dens, but on June 4, the eggs had disappeared. As it requires from five to seven days, under normal conditions, for these eggs to hatch, it was apparent to the culturist that the eggs had been eaten, so, on June 6, we removed the sixty adult Channel catfish by using a two hundred foot seine fourteen feet deep. It required two drags to catch all the fish.

MALES HAD TAPEWORMS.

Examination disclosed that some of the fishes were bloated and that they had apparently been in fierce fights. There were purple spots about their mouth and under their lower lips. One of these peculiarly marked fish was opened and it was ascertained that there were a number of tapeworms (*Onchobothrium uncinatum*) in the small intestines about where the gall sac enters. This specimen was given a very careful examination and a symptom was discovered. This symptom was a swelling of the head or perhaps, more specifically speaking, of the jowls. The swelling was back of the eyes and the apex of the swelling was in a half-moon shape following the contour of the gill openings, and about half-way between the eyes and the gill openings. The fish appeared to have the mumps. All of the fish in the ponds were carefully examined and it was found that twenty-five of the thirty males, in the pond, were affected. A female

was opened and found to be in a healthy condition and ready to spawn.

It was apparent that the males were eating the spawn. Examinations of the five stomachs removed at the time disclosed that these fish had been eating everything that came to their mouths. It is not the nature of Channel catfish to eat moss, especially algae. These males had been eating algae, as their alimentary canals were filled with wads of undigested algae and particles of plant and animal matter.

TAPEWORM REMEDY FOUND.

All infected fish were taken from the pond and placed in a cement container, where they could be kept under control. On June 7, two specimens were each given two grains of santonin and two grains of calomel. The tablets were dissolved in a tablespoon full of water and using a syringe fitted with a quarter-inch hard rubber tube about one foot long, the medicine was injected down the fishes' mouth into the alimentary canal about seven inches from the snout. Twenty-four hours afterwards the fish were opened and examined. This was on June 8. It was found that the alimentary canal was free from tapeworms. That part of the canal where the tapeworms attached themselves was placed under a glass and it was not difficult to see the holes in the intestines where the worms' heads had been embedded. On June 9, the other twenty males were each given a dose of two grains of calomel and two grains of santonin. The santonin was to kill the worm, thereby causing it to release its hold, and the calomel was used as a purgative. These fish were fed crayfish the following day. They were ravenously hungry, eating about six large crayfish each in twenty-four hours. On June 10, the treated fish were returned to the breeding pond where the ripe females had been left. It would have been better, perhaps, to have held the male fish a day or two longer, but we were anxious to get the eggs fertilized the females were ready to deposit.

During the next two weeks we were successful in procuring twelve spawns of hatched catfish from the dens in this pond. We were positive that had we not treated the infected males that we would not have secured any results from this pond of Channel cat. None of the females was infected and we are unable to account for this immunity.

In this connection, it is interesting to note that the females had been fighting the males for the males showed signs of rough treatment. It might be that, contrary to opinion, the females helped guard the spawn, or it is possible that these marked-up males had been trying to seize the spawn from the dens of males, free from tapeworm, as there were five males found in the pond showing no symptoms of being infected.

We have nothing but opinion as to how the fish contracted tapeworms. This particular worm has two cycles, so we believe. It must be taken into the stomach by the fish in the form of larvae or of a cyst, after which it develops into the tapeworm. The head must be destroyed in order to kill the entire worm, as it appears to grow in sections.

It may be that our identification of this tapeworm is in error but it fits the description of the *Onchobothrium uncinatum* in practically every detail.

So far as the Kansas Fish and Game Department knows, the Spotted Channel catfish, in its natural habitat, does not contract this tapeworm.

MORE SUBJECT TO PARASITES IN PONDS.

Our observations, lasting about three years, lead us to believe that the Channel catfish is subject to larger discomforts from the attack of the parasite *Protozon ichthyophthirius* when under pond control than in its natural habitat. This parasite has been the subject of a very enlightening treatise by Mr. Herbert F. Prytherch, scientific assistant in the U. S. Bureau of Fisheries. The treatise is in the Bureau of Fisheries Document No. 959. Briefly, the parasite causes sores to come upon the skin of the fish. These sores subject the fish to fungous growth, causing death. It is believed that this parasite found its way into the Kansas Fish Hatchery waters by a shipment of moss. This parasite has attacked only the Channel catfish, in so far as we have observed. We have the Goujon, Horn Pout and now and then a Blue cat in the Hatchery. The parasite causes the fish to become very uneasy, at first. Apparently it tries to scrape its sides against the bottom or banks of the pond. We have observed the actions of Channel cat attacked by this parasite, while the fish was in an aquarium. The microscopic animals will soon cover the fish until it looks like it had the smallpox, and we have given his parasitical disease the colloquial name of smallpox. The parasite seems

to take the vitality from the fish, which declines to eat and finally falls a victim to the fungus. The parasite apparently reproduces by a process of dissolution, each particle in turn becoming an adult parasite.

Our trouble at the Kansas Fish Hatchery with this parasite is confined to the advanced fry Spotted Channel cat. Apparently the adults are immune when permitted to range at large in the ponds.

We first noted ill effects of the parasite in 1923, but it was not until 1924 that we identified the cause. The young fish declined food, grew weaker day by day and finally perished, either through starvation or loss of blood. The fungous growth did not attain proportions sufficiently to kill the fry, in our opinion. Weakened by the attacks of this parasite, the fry would become entangled in algae and many perished that way. Ponds in which this parasite wrought the most havoc were located near the source of the main water supply of the Hatchery, and were fed by risers (elbow pipe) from a pond of approximately three acres in area. There was considerable muck in the water in the Hatchery in 1924 and the water in the ponds, where we had Channel cat fry that were attacked by this parasite, was turbid. It is interesting to know that in one pond immediately adjacent to a series of three ponds in which we had Channel cat, the loss of fish from this parasite was very small. This pond was well stocked with stoneworts which cleared the water. We do not believe the moss is a preventative for this parasite, however, although it may be that the parasite thrives better in turbid water than in clear. As the adult parasite, after gorging itself on the fish, drops and settles to the bottom, it may be the moss screen acts as a control.

We have been unable to discover a remedy. We have tried the fisherman's cure all, salt, and a number of acids. None was effective although we could kill the parasite, but in doing so also killed the young fish.

It has been suggested that an effective way to destroy this parasite is to place the infected fish in a container in which there is small per cent of blue vitrol and apply air pressure. It is our opinion that preventative measures are more to be desired than remedies because it is so difficult to treat the fish, once they are attacked. We do not believe this parasite will materially affect young Channel catfish if these fish

have clear running water in sand and gravel beds and also have dens where they can hide from the blazing hot sun.

And now American fish culturists face a tremendous task—that of providing fish for a hundred million people to catch. The number of fishermen is increasing annually, the number of polluted streams and lakes is also increasing annually. Pollution drives out trout quickly. Bass will withstand more pollution than trout, I believe, but after a while it gets them too. The Spotted Channel catfish is the gamest fish found in polluted waters. It resists pollution where other fish perish and pollution has little effect upon its fighting qualities or its desirability as food. Attention of fish culturists everywhere should be called to this fish and it should have a much wider distribution in America than it has.

BIOLOGICAL OBSERVATIONS ON THE ATLANTIC STURGEON

(*Acipenser sturio*)

PROFESSOR N. BORODIN.

In view of the importance and need of introducing methods of artificial propagation or legislative restrictions on sturgeon fishing in the Delaware and other rivers of the Atlantic coast, certain biological observations made by me in the spring of 1925 have a timely bearing.

SPAWNING

MIGRATION—In 1925 the first sturgeon was caught in the Delaware River on April 23. A few were taken during the last of April and the first part of May. The most abundant catches were made between May 12 and May 22 inclusive. During the rest of May and the first ten days of June, the catch was very poor, scarcely one fish per day, and on June 10 the sturgeon fishermen ceased fishing. The principal fishing is carried on in a comparatively narrow arm of the river between Pea-Patch Island and the New Jersey shore just opposite Delaware City where there is a channel about two and one-half miles long with a depth of six to seven fathoms and a strong current. In its upper part near the east shore is a bottom of hard clay where, according to the observations of their fishermen, the sturgeons gather for spawning.

SPAWNING GROUNDS—Spawning occurred in 1925 between the tenth and the twenty-second of May when ripe males and females were taken together in the same locality. These sturgeons were examined by me when they were delivered at the Delaware City wharf. Seven female sturgeons were observed with ripe, running roe and three males with ripe milt. Their bellies were blood red from stirring against each other or against the hard bottom and without question they were caught during the act of spawning. The water in the spawning grounds has a temperature from 56° to 64° F. at this time of year, the temperature being lower during the ebbing and higher during the flowing tide. Sturgeons which pass through the straits find good spawning grounds near Chester and on the New Jersey shore

where there is hard stony and gravelly bottom. In previous years fishermen from Penn's Grove and Pedricktown made a practice of catching the fish during spawning.

In July and August sturgeons are found in the Delaware River with hard roe. It is possible that these sturgeons reach the upper parts of the river and spawn later than those which are caught in the spring in the lower river. Reasoning by analogy from our knowledge of the Russian sturgeon, it would appear that there may be several runs of the sturgeon with different times of spawning, although the principal run invariably occurs in the spring.

MALES AND FEMALES—The low ratio of male to female sturgeons in the Delaware River's catch presents a peculiarity which is important in view of artificial propagation. The fact that the females constituted from 80 to 90 per cent. of the entire spring catch raises the question whether sturgeon schools in the Delaware River always possess such an abnormal percentage of males. In my experience with other species of sturgeons the males are more numerous during the spawning runs than the females. Possibly because of their smaller size few males are caught in the large-meshed nets. The gill nets used in the Delaware River have a minimum mesh of thirteen inches when stretched and a net of this size will hold only large sturgeons over 200 pounds in weight. Male sturgeons as a rule only average from 100 to 150 pounds and rarely attain the weight of 200 pounds. This theory can be verified by the use of a net with smaller meshes, e. g. from 10 to 10½ inches.

STURGEON ROE.

Between May 13 and June 10 the sturgeons which were examined showed striking differences in the size, stage of development, color, and consistency of the roe. Sturgeon roe may be divided into three classes from the standpoint of its commercial value which correspond with its biological or rather its physiological qualities.

"HARD" ROE—"Hard" roe or good roe is present when the two long halves of the enormous ovary, which measures up to four to five feet in length according to the size of the fish, are full of eggs still confined in the ovary in hard, solid formation. The separate eggs can be extruded from the mass only by rubbing the roe through a sieve. This class

of roe is most appreciated and in fact is the only kind demanded for high-class caviare production. The eggs may be large or small, of different color, and more or less fatty, but the common quality of hardness and suitability for curing permits a single classification.

From a biological standpoint the roe is not yet ripe for propagation. The eggs are still in the process of development as indicated by differences in size and appearance. Some eggs are only 2 mm. in diameter and have a uniform yellowish gray color with a black spot on the top of the egg. Others are 2.5 mm. in diameter and already possess a distinct whitish band on the upper part. When observed in mass this roe is of a slightly lighter color and for that reason is called by caviare dealers "light" roe. These light-colored eggs are more advanced in development but are not yet completely ripe.

RIPE ROE—Ripe roe presents a different appearance. The individual eggs liberated from the ovarian glands together with a slimy liquid fill the body cavity of the sturgeon. Some of these eggs flow freely from the genital opening, but the greater part remain in the body cavity. At times part of the roe remains in "loafs", that is, the eggs are still held together by tissue. The size of the eggs has obtained a maximum of 2.6 mm. Owing to their soft membrane, they rupture easily and therefore they are not suitable for curing. The light circular band and sometimes an additional black circle are distinct characteristics of these ripe eggs which are chiefly of value for artificial impregnation and propagation. I have observed several instances where this roe was purchased at a low price, hardened by salting and sold in the New York market for seventy-five cents a pound. Ripe roe has the particular quality that its outside, glary membrane readily imbibes water and becomes glutinous and sticky.

"PASTERS"—Sometimes roe sturgeons are called pasters because of the appearance of roe which looks like a slimy, grayish white paste. This paste consists of squeezed eggs, their white yolks, and ruptured membranes. It is neither suitable for making caviare nor for propagation purposes and represents a complete waste. Several explanations of this peculiar deterioration of sturgeon roe have been offered. Some observers consider that it is the result of the rough handling of the fish by the fishermen or keeping the

fish too long exposed to sunshine. Others believe that the water has entered into the belly either through wounds made by gaffs or through the genital orifice (Ryder). Possibly these causes may operate in certain cases, but I have examined two or three "paster" sturgeons from the Delaware River which were alive at the time of examination and had no wounds. Observations in Russia upon roe sturgeons kept for a long time in confinement during warm weather show a degeneration of the eggs which renders the roe unsuitable either for caviare or for impregnation. A similar condition has been observed in the Caspian Sea when female with ripe roe cannot reach the fresh water spawning grounds and is forced to remain in localities unsuitable for spawning. These cases evidently result from the retention of the eggs inside the body longer than the spawning period required by nature.

Among sixty-three sturgeons caught in the Delaware River in the spring of 1925, three or 5 per cent, were "pasters", seven or 11 per cent. contained ripe roe, and the remaining fifty-three or 84 per cent., had hard roe. A hard roe is present in sturgeons which are taken during the entire spring; whereas, ripe roe is found only during the short spawning season.

EGGS—Omitting differences in shade, sturgeon eggs are always of a blackish color. It is exceptional to find sturgeons with full-grained white roe. Such instances are due to the absence of pigment. This roe when packed separately can be sold in the market. I have observed one case of spotted roe in which the great majority of eggs were black, but in which there were many scattered white eggs. In order to obtain a favorable price for this roe, it was necessary to pick out the white eggs. Close examination showed no abnormality other than the light color, the structure and consistency not differing from the ordinary sturgeon egg.

DEVELOPMENT OF STURGEON.

FECUNDITY—The number of eggs produced by the Atlantic sturgeon is extraordinarily large, running from 500,000 to 2,500,000. Two methods were employed for the determination of the number of eggs: the method of Ryder of counting eggs in a certain volume such as one gallon, and my own method of counting eggs in a small portion, the weight of which was determined accurately, and the number of eggs

computed from the entire weight of the roe. In view of the differences in the size of the eggs it would seem that the first method was more satisfactory, but since the eggs of a single fish as a rule are of uniform size, the method of weight because of its greater accuracy is to be preferred. For example, two grams of hard roe contained 116 eggs with an average diameter of 2 mm. On this basis one kilogram would contain 58,000 eggs or 1 pound avoirdupois 26,318 eggs. From this sturgeon 40 pounds of roe or in round numbers 1,000,000 eggs were removed. The number varies with the size and weight of the sturgeon ranging from 20 to 100 lbs. or from 500,000 to 2,500,000 eggs. The largest roe observed by me weighed 80 pounds and the smallest 18 pounds, or the equivalent of 2,000,000 and 500,000 eggs respectively. The number of eggs according to Ryder's calculation of 168,000 eggs per gallon runs from 800,000 to 2,460,000.

GROWTH—Although naturally very prolific, the Atlantic sturgeon is approaching extinction both in Europe and in America because an insufficient number are permitted to reach suitable spawning grounds and because of the lack of artificial propagation. According to recent investigation, the growth of the sturgeon is very slow. Mature specimens of American Lake Sturgeon (*A. rubicundus*)¹ and the Russian Sturgeon (*A. stellatus*)² are not less than 15 to 22 years old. As far as I know no studies have been made for determining the age of the Atlantic sturgeon, but in all probability, like the Lake and Russian sturgeon, it requires 15 years to attain a commercial size. The growth of the Atlantic sturgeon takes place almost exclusively in the ocean. The sturgeon fry remain only for the first few weeks near the spawning grounds and in the lower reaches of the rivers and bays which lead to the spawning ground.

"SLUNKER" STURGEON--After spawning, the so-called "slunkers" run back to the ocean where they remain until new roe is formed for a second spawning. It has been definitely determined that the Russian Sturgeon (*A. Guldenstadti*) spawn every other year and Derjavin² expresses the opinion that several years pass between the first and second laying of the eggs with *A. stellatus*. An examination of the ovaries of the "slunker" sturgeons affords some information upon the spawning time of the Atlantic sturgeon. Their body cavities are almost empty, the ovaries presenting only small

remnants of the gland which contain minute white grains or eggs of future roe. These embryonic eggs are not uniform in size or shape, varying from 0.1 to 0.75 mm. in diameter. Some are round, others oval or even angular in form. Later as they increase in size during the summertime, they acquire a yellow color. The rate of growth of eggs in the Atlantic sturgeon is unknown, but in all probability this species spawns every other year.

PRACTICAL CONSIDERATIONS.

CAUSES OF DEPLETION—The number of sturgeons in the Delaware River is diminishing each year. The present condition is the result of the combination of overfishing, which destroys the spawning adults, the killing of young sturgeons by the shad nets, and trade waste pollution. The pollution of the Delaware River to judge from preliminary observations in the spring of 1925 is not excessive. On the spawning grounds and in Delaware Bay strong tidal currents keep the water free from any injurious pollution. At Chester the water is seriously polluted by oil and at Penn's Grove by a dye which in some places is so intense as to stain the nets and hands of the fishermen blue.

REMEDIAL MEASURES—In order to restore the sturgeon fishery of Delaware River it has been suggested that all sturgeon fishing be prohibited for at least five years or that a closed season from June 15 to August 15 be enacted. In my opinion, both these measures cannot materially improve the present situation. Already the sturgeons are too few to furnish sufficient fry for stocking the river under natural conditions. Since about 95 per cent. of the spawned eggs are not impregnated, seven spawning female sturgeons with a total of 10,000,000 eggs would yield only 250,000 impregnated eggs, which in turn, on the basis of a ten per cent. hatch of fry, would furnish but 50,000 fry. Owing to adverse conditions which beset the young sturgeon in its early years, most of these would perish in the open ocean and comparatively few sturgeons would reach maturity.

In stocking the Delaware River several millions of fry must be systematically planted. The only means of producing larger numbers of fry from the few spawning sturgeon is to impregnate and hatch artificially all available ripe eggs. Under well-organized methods of artificial propagation, 95,000,000 eggs can be impregnated and about

7,000,000 sturgeon fry can be successfully hatched out. The systematic planting over a period of ten years will restock the Delaware River and the neighboring coast with sturgeons unless general conditions become worse than at the present time. In order to secure ripe eggs for propagation, the sale and salting of "runners" with ripe eggs must be prohibited by Delaware, New Jersey, and Pennsylvania which border on Delaware Bay. Fishermen should be encouraged by suitable compensation to deliver all ripe roe sturgeons to officials on the fishing grounds or at the hatcheries.

The closed season should only be used as a measure to prevent wasteful sturgeon fishing in the summertime when the roe is not of the best quality and cannot be marketed under favorable conditions. The present law does not permit the catch of sturgeons less than five feet in length. Evidently it was enacted for the purpose of protecting the small sturgeons called "Mammoushes", which are from two to three feet in length. It is unsatisfactory because a five foot sturgeon is a large fish and males of this size are mature, and because in the Delaware River is another species of sturgeon, *A. breviorstris*, which is of small size. Roe sturgeon of this species become mature at a shorter length than five feet. Most of the so-called "Mammoushes" may be merely the short-nosed sturgeons which live in the river all the year round and even spawn when confined in ponds³.

Legislation in order to be both reasonable and useful must be based on biological investigation. The inefficiency of the present law is amply illustrated by the decreasing supply of sturgeons. Only the prompt inauguration of artificial propagation with the recently improved Russian methods of handling the eggs and fry can remedy the situation. The details of artificial propagation must be elaborated carefully by the Federal Government in co-operation with the State authorities and the necessary money must be appropriated if the sturgeon fishery of the Delaware River is to be revived.

BIBLIOGRAPHY.

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2. Derjavin A. Bull. of the Ichthyological Laboratory of Baku 1922.
3. Meehan. Trans. Am. Fishery Soc. 1909 page 85.

APPENDIX

American Fisheries Society

Organized 1870

CERTIFICATE OF INCORPORATION

We, the undersigned, persons of full age and citizenship of the United States, and a majority being citizens of the District of Columbia, pursuant to and in conformity with sections 599 to 603, inclusive, of the Code of Law for the District of Columbia, enacted March 3, 1901, as amended by the acts approved January 31 and June 30, 1902, hereby associate ourselves together as a society or body corporate and certify in writing:

1. That the name of the Society is the American Fisheries Society.

2. That the term for which it is organized is nine hundred and ninety-nine years.

3. That its particular business and objects are to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish; with power:

(a) To acquire, hold and convey real estate and other property, and to establish general and special funds.

(b) To hold meetings.

(c) To publish and distribute documents.

(d) To conduct lectures.

(e) To conduct, endow, or assist investigation in any department of fishery and fish-culture science.

(f) To acquire and maintain a library.

(g) And, in general, to transact any business pertinent to a learned society.

4. That the affairs, funds and property of the corporation shall be in general charge of a council, consisting of the officers and the executive committee, the number of whose members for the first year shall be seventeen, all of whom shall be chosen from among the members of the Society.

Witness our hands and seals this 16th day of December, 1910.

SEYMOUR BOWER (Seal)

THEODORE GILL (Seal)

WILLIAM E. MEEHAN (Seal)

THEODORE S. PALMER (Seal)

BERTRAND H. ROBERTS (Seal)

HUGH M. SMITH (Seal)

RICHARD SYLVESTER (Seal)

Recorded April 16, 1911.

CONSTITUTION AND BY-LAWS.

(As amended to date)

ARTICLE I

NAME AND OBJECT

The name of this Society shall be American Fisheries Society. Its object shall be to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; the uniting and encouraging of all interests of fish culture and the fisheries, and the treatment of all questions regarding fish, of a scientific and economic character.

ARTICLE II

MEMBERSHIP

Active Members.—Any person may upon a two-thirds vote of the members present at any regular annual meeting and upon the payment of one year's dues become an active member of this Society.

The annual dues of active members shall be three (\$3.00) dollars per year, payable in advance. In case of non-payment of dues for two consecutive years, notice shall be given by the treasurer in writing, and such member remaining delinquent after one month from the date of such notice, his name shall be dropped from the roll of the society. Such delinquent member, having been dropped for non-payment of dues shall be ineligible for election as a new member for a period of two years, except upon payment of arrears.

Club Members.—Any sporting of fishing club or society, or any firm or corporation, upon a two-thirds vote of the members present at any regular annual meeting and upon the payment of one year's dues, may become a club member of this Society. The annual dues of club members shall be five (\$5.00) dollars per year.

Libraries.—Libraries shall be admitted to membership upon application and the payment of one year's dues. The annual dues for libraries shall be three (\$3.00) per year.

State Memberships.—Any State, Provincial or Federal Department of the United States, Canada or Mexico may, upon application and the pay-

ment of one year's dues become a state member of this Society. The Annual dues for State Memberships shall be ten (\$10.00) dollars per year.

Life Memberships.—Any person may, upon a two-thirds vote of the members present at any regular annual meeting and the payment of fifty (\$50.00) dollars become a life member of this Society and shall thereafter be exempt from payment of annual dues.

Patrons.—Any person, society, club, firm or corporation, on approval of the Executive Committee and the payment of fifty (\$50.00) dollars or more, may become a patron of this Society with all the privileges of a life member, and shall be listed in all the published membership lists of the Society.

Honorary and Corresponding Members.—Any person may be made an honorary or corresponding member upon a two-thirds vote of the members present at any regular annual meeting of the Society. The President (by name) of the United States, the Governors (by name) of the several states and the Secretary of Commerce of the United States (by name) shall be honorary members of the Society.

Election of Members Between Annual Meetings.—The President, Secretary and Treasurer of the Society are hereby authorized during the time intervening between annual meetings, to receive and act upon all applications for individual and club memberships. A majority of such committee shall decide upon the acceptance of such applications.

Voting.—Active members and Life members only shall have the right to vote at regular or special meetings of the Society. Fifteen voting members shall constitute a quorum for the transaction of business.

ARTICLE III

FUNDS

Current Fund.—All moneys received from the payment of dues of active members, club members, libraries, life members, state members, sale of Transactions, contributions thereto, and from any miscellaneous sources, shall be credited to the Current Fund of the Society and shall be paid out only on vouchers regularly approved by the President and Secretary.

Permanent Fund.—The President, Secretary and Treasurer shall be the Trustees of the Permanent Fund. All moneys received from patrons, bequests and contributions thereto shall be credited to the Permanent Fund of the Society. Such fund shall be invested by the treasurer in such manner as may be approved by the trustees of such fund. The members of the Society shall, at each annual meeting determine the disposition of interest accruing from such investment.

ARTICLE IV

OFFICERS

The officers of this Society shall be a president and a vice-president, who shall be ineligible for election to the same office until a year after the expiration of their term; a secretary, a treasurer, a librarian, and an executive committee of seven, which, with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session—four to constitute a quorum.

In addition to the officers above named there shall be elected annually five vice-presidents who shall be in charge of the following five divisions or sections:

1. Fish Culture.
2. Commercial Fishing.
3. Aquatic biology and physics.
4. Angling.
5. Protection and Legislation.

No officer of this Society shall receive any salary or compensation for his services and no allowances shall be made for clerical services except by vote of the Society at regular annual meetings.

Duties of Officers.—The President shall preside at the Annual and all special meetings of the Society, shall be ex-officio chairman of the Council of the Society, and shall exercise general supervision over the affairs of the Society.

The Vice-President shall act in the place of the President in case of absence or inability of the latter to serve.

The Secretary shall keep the records of the Society, attend to the publication and distribution of its Transactions, attend to its correspondence, promote its membership, and arrange for annual and special meetings.

The Treasurer shall receive and collect all dues and other income of the Society, shall have the custody of its funds and pay all claims which have been duly approved. The Treasurer shall furnish a bond in the sum of one thousand (\$1,000.00) dollars to be approved by the executive committee and to be paid for by the Society.

The Librarian shall have the custody of the library of the Society, including its permanent records and printed Transactions and shall have charge of the sale of surplus copies of such Transactions. Other officers shall perform such duties as shall be assigned them by the President.

ARTICLE V

MEETINGS

The regular meeting of the Society shall be held once a year, the time and place being decided upon at the previous meeting, or, in default of such action, by the executive committee.

ARTICLE VI

ORDER OF BUSINESS

1. Call to order by the President.
2. Roll call of members.
3. Applications for memberships.
4. Reports of officers.
 - a. President.
 - b. Secretary.
 - c. Treasurer.
 - d. Vice-Presidents of Divisions.
 - e. Standing Committees.
5. Committees appointed by the President.
 - a. Committee of five on nomination of officers for ensuing year.
 - b. Committee of three on time and place of next meeting.
 - c. Auditing committee of three.
 - d. Committee of three on program.
 - e. Committee of three on publication.
 - f. Committee of three on publicity.
6. Reading of papers and discussions of same.
(*Note*—In the reading of papers preference shall be given to the members present).
7. Miscellaneous business.
8. Adjournment.

ARTICLE VII

CHANGING THE CONSTITUTION

The Constitution of the Society may be amended, altered or repealed by a two-thirds vote of the members present at any regular meeting, provided at least fifteen members are present at said regular meeting.

American Fisheries Society

LIST OF MEMBERS, 1925-1926.

(Showing Year of Election to Membership)

HONORARY MEMBERS

The President of the United States

The Secretary of Commerce of the United States.

The Governors of the several States.

'08 Antipa, Prof. Gregoire, Inspector-General of Fisheries, Bucharest, Roumania.

'06 Besana, Giuseppe, Lombardy Fisheries Society, Via Rugabello 19, Milan, Italy.

'09 Blue Ridge Rod and Gun Club, Harper's Ferry, W. Va.

'93 Borodin, Nicolas Brooklyn Museum, Brooklyn, N. Y.

'12 Calderwood, W. L., Inspector of Salmon Fisheries for Scotland, Edinburgh, Scotland.

'04 Denbigh, Lord, London, England.

'04 Kishinouye, Dr. K., Imperial University, Tokyo, Japan.

'88 Lake St. Clair Shooting and Fishing Club, Detroit, Mich.

'17 Mercier, Honore, Minister of Colonization, Mines and Fisheries, Quebec, Canada.

'09 Nagel, Hon. Chas., St. Louis, Mo.

'95 New York Association for the Protection of Fish and Game, New York City.

'08 Nordqvist, Dr. Oscar Fritjof, Superintendent of Fisheries, Lund, Sweden.

'06 Perrier, Prof. Edmond, Director Museum of Natural History, Paris, France.

'92 Vinciguerra, Prof. Dr. Decio, Director Royal Fish Culture Station, Rome, Italy.

CORRESPONDING MEMBERS

'84 Apostolides, Prof. Nicoly Chr., Athens, Greece.

'87 Armistead, J. J., Dumfries, Scotland.

'04 Ayson, L. F., Commissioner of Fisheries, Wellington, New Zealand.

'22 Director, All-Russian Agricultural Museum, Fontanka 10, Petrograd, Russia.

'22 Director of Fisheries (British Malay), Singapore, Straits Settlements.

'08 Higginson, Eduardo, Consul for Peru, New York City.

'84 Landmark, A., Inspector of Norwegian Fresh Water Fisheries, Christiania, Norway.

- '22 Library, National Museum of Natural History, Paris, France.
- '84 Marston, R. B., Editor of the Fishing Gazette, London, England.
- '08 Potteau, Charnley, Lommel, Belgium.
- '84 Sars, Prof. G. O., Christiania, Norway.
- '10 Stead, David G., Fisheries Department, Sydney, New South Wales, Australia.

PATRONS

- '14 Alaska Packers Association, San Francisco, Calif.
- '15 Allen, Henry F., (Agent, Crown Mills), 210 California St., San Francisco, Calif.
- '15 American Biscuit Co., 815 Battery St., San Francisco, Calif.
- '15 American Can Co., Mills Building, San Francisco, Calif.
- '15 Armour & Co., Battery and Union Sts., San Francisco, Calif.
- '15 Armsby, J. K., Company, San Francisco, Calif.
- '15 Atlas Gas Engine Co., Inc., Foot of 22nd Avenue, Oakland, Calif.
- '15 Balfour, Guthrie & Co., 350 California St., San Francisco, Calif.
- '15 Bank of California, N. A., California and Sansome Sts., San Francisco, Calif.
- '15 Bloedel-Donovan Lumber Mills, Bellingham, Wash.
- '15 Bond and Goodwin, 485 California St., San Francisco, Calif.
- '15 Burpee and Letson, Ltd., South Bellingham, Wash.
- '15 California Barrel Co., 22d and Illinois Sts., San Francisco, Calif.
- '15 California Door Co., 43 Main St., San Francisco, Calif.
- '15 California Stevedore and Ballast Co., Inc., 210 California St., San Francisco, Calif.
- '15 California Wire Cloth Company, San Francisco, Calif.
- '15 Caswell, Geo. W., Co., Inc., 503-4 Folsom St., San Francisco, Calif.
- '15 Clinch, C. G., & Co., Inc., 144 Davis St., San Francisco, Calif.
- '15 Coffin-Redington Co., 35-45 Second St., San Francisco, Calif.
- '15 Columbia River Packers Association, Astoria, Ore.
- '15 Crane Co. (C. W. Weld, Mgr.) 301 Brannon St., San Francisco, Calif.
- '15 Dodge, Sweeney & Co., 36-48 Spear St., San Francisco, Calif.
- '15 First National Bank of Bellingham, Bellingham, Wash.
- '15 Fuller, W. P., & Co., 301 Mission St., San Francisco, Calif.
- '15 Grays Harbor Commercial Co., Foot of 3d St., San Francisco, Calif.
- '15 Hendry, C. J., Co., 46 Clay St., San Francisco, Calif.
- '15 Jones-Thierbach Co., The, Battery and Merchant Sts., San Francisco, Calif.
- '15 Knapp, The Fred H., Co., Arcade-Maryland Causalty Building, Baltimore, Md.
- '15 Linen Thread Co., The, (W. A. Barbour, Mgr.), 443 Mission St., San Francisco, Calif.
- '15 Mattlage, Chas. F., Company, 335 Greenwich St., New York City.

- '15 Nauman, C., & Co., 501-3 Sansome St., San Francisco, Calif.
- '15 Oliver Salt Co., Mt. Eden, Calif.
- '15 Morrison Mill Co., Inc., Bellingham, Wash.
- '15 Morse Hardware Co., Inc., 1025 Elk St., Bellingham, Wash.
- '15 Pacific Hardware and Steel Co., 7th and Townsend Sts., San Francisco, Calif.
- '15 Pacific States Electric Co., 575 Mission St., San Francisco, Calif.
- '15 Phillips Sheet and Tin Plate Co., Weirton, W. Va.
- '15 Pope and Talbot, Foot of 3d St., San Francisco, Calif.
- '15 Puget Sound Navigation Co., Seattle, Wash.
- '15 Ray, W. S., Mfg. Co., Inc., 216 Market St., San Francisco, Calif.
- '15 Schmidt Lithograph Co., 2d and Bryant Sts., San Francisco, Calif.
- '15 Schwabacher-Frey Stationery Co., 609-11 Market St., San Francisco, Calif.
- '15 Ship Owners' and Merchants' Tug Boat Co., Foot of Green St., San Francisco, Calif.
- '15 Sherwin-Williams Co., The, 454 Second St., San Francisco, Calif.
- '15 Smith Cannery Machine Co., 2423 South First Avenue, Seattle, Wash.
- '15 Standard Gas Engine Co., Dennison and King Sts., Oakland, Calif.
- '15 Standard Oil Co. of California, Standard Oil Building, San Francisco, Calif.
- '15 U. S. Rubber Co. of California (W. D. Rigdon, Mgr.) 50-60 Fremont St., San Francisco, Calif.
- '15 U. S. Steel Products Co., Rialto Building, San Francisco, Calif.
- '15 Wells Fargo National Bank of San Francisco, Montgomery and Market Sts., San Francisco, Calif.
- '15 Western Fuel Co., 430 California St., San Francisco, Calif.
- '15 Western Meat Co., 6th and Townsend Sts., San Francisco, Calif.
- '15 White Bros., 5th and Brannan Sts., San Francisco, Calif.

ACTIVE MEMBERS

- '21 Abrams, Milton 560 Brooke Ave., New York City, N. Y.
- '23 Acklen, Col. Joseph H. Nashville, Tenn.
- '16 Adams, Prof. Charles C. New York State College of Forestry, Syracuse, N. Y.
- '13 Adams, William C. Division of Fisheries & Game, State House, Boston, Mass.
- '18, '23 Ainsworth, Seth M. Supt., Bureau of Fisheries, Saratoga, Wyoming.
- '20 Albert, W. E. State Fish & Game Warden, Des Moines, Iowa.
- '98 Alexander, George L. Grayling, Mich.
- '25 Allsopp, Edward E. 33 East Kinney St., Newark, N. J.
- '23 Amsler, Guy Department of Fish & Game, Little Rock, Ark.
- '24 Anderson, Anders Shoshone Falls, Jerome, Idaho.
- '08 Anderson, August J. Box 704, Marquette, Mich.
- '14 Anderson, T. T. 4241 Folsom Avenue, St. Louis, Mo.
- '24 Annin, Harry K. Spring Street, Caledonia, N. Y.

- '14 Annin, Howard Caledonia, N. Y.
- '78 Annin, James Caledonia, N. Y.
- '21 Armstrong, Ronald Kennedy Bellister Castle, Haltwhistle, Northumberland, England.
- '10 Augur, W. A. 33 Fulton Street, New York City, N. Y.
- '06 Avery, Carlos 2273 Wool worth Bldg., New York City, N. Y.
- '01 Babcock, John P. Provincial Fisheries Department, Victoria, B. C., Canada.
- '12 Babcock, William H. 140 South Dearborn St., Chicago, Ill.
- '18 Bailey, Arthur T. R. F. D. 1, Nashua, N. H.
- '23 Baird, John Director, Department of Conservation, Lansing, Mich.
- '15 Balch, Howard K. 158 West Austin Ave., Chicago, Ill.
- '01 Baldwin, O. N. U. S. Bureau of Fisheries, Saratoga, Wyo.
- '98 Ball, E. M. U. S. Bureau of Fisheries, Washington, D. C.
- '10 Ballard, Thurston 912 East Broadway, Louisville, Ky.
- '23 Bangham, Ralph V. Wooster College, Wooster, Ohio
- '20 Barbour, F. K. 96 Franklin St., New York City, N. Y.
- '05 Barbour, Prof. Thomas Museum of Comparative Zoology, Cambridge, Mass.
- '17, '24 Barney, Raymond L. Middlebury College, Middlebury, Vt.
- '10 Barron, James T. Thlinket Packing Corporation, 1210 Yeon Bldg. Portland, Ore.
- '19-'25 Bartlett, Mott L. Commissioner of Fisheries & Game, Concord, N. H.
- '23 Baskett, Cecil M. 925 Syndicate Trust Bldg., St. Louis, Mo.
- '12 Bauer, A. 2500 South Dearborn St., Chicago, Ill.
- '22 Bayne, Bliss Game & Fish Department, Capitol Bldg., Cheyenne, Wyoming.
- '24 Beakbane, Lionel R. F. D. 2, Gansevoort, N. Y.
- '23 Beard, Harry R. U. S. Fisheries Laboratory, San Pedro, Cal.
- '00 Beeman, Henry W. New Preston, Conn.
- '18 Bellisle, J. A. Inspector General of Fisheries & Game, Quebec, Canada.
- '80 Belmont, Perry 1618 New Hampshire Ave., Washington, D. C.
- '25 Bengard, John P. Valley Ranch, New Mexico.
- '13 Berg, George Indiana Fish Commission, Indianapolis, Ind.
- '06 Berkhaus, Jerry R. Torresdale Fish Hatchery, Holmesburg, Philadelphia, Penn.
- '19 Bernard, Gus Bernard Fish Company, Atchafalaya, La.
- '23 Berwick, Dudley Eunice, La.
- '24 Bitzer, Ralph Montague, Mass.
- '24 Blanchard, Charles State Fish Hatchery, Unionville, Conn.
- '24 Bobleter, J. W. Supt., Yellowstone Hatchery, Emigrant, Mont.
- '25 Bolles, Henry J. U. S. Fisheries Station, Bozeman, Montana.
- '23 Bolstad, Sidney L. 4344 N. Winchester Ave., Chicago, Ill.
- '14 Bolton, C. C. 1550 Hanna Bldg., Cleveland, Ohio.
- '20 Bonner, Albert E. Coopersville, Mich.
- '02 Booth, DeWitt C. U. S. Bureau of Fisheries, Spearfish, S. D.
- '14 Bordenkecher, William R. R. 19, Haughville Station, Indianapolis, Ind.
- '25 Borger, Samuel I. Brookhaven, Long Island, N. Y.
- '25 Bottler, P. G. State Fish Hatchery, Emigrant, Montana.
- '23 Bourland, Dubart E. U. S. Bureau of Fisheries, Tupelo, Miss.
- '00 Bower, Ward T. U. S. Bureau of Fisheries, Washington, D. C.
- '20 Breder, C. M. Jr., New York Aquarium, New York City, N. Y.
- '16 Brown, Dell U. S. Bureau of Fisheries, Mammoth Springs, Ark.

- '14 Brown, Ernest Clive Box 107, Station G., New York City, N. Y.
- '04 Brown, G. W. N. U. S. Bureau of Fisheries, Orangeburg, S. C.
- '23 Brunson, J. H. Louisville, Nebraska
- '10 Bryan, Prof. William Alanson Director, Los Angeles Museum,
Exposition Park, Los Angeles, Cal.
- '25 Buckmaster, Walter C. Bozeman, Montana.
- '18 Buckstaff, George A. 1101-1501 South Main St., Oshkosh, Wis.
- '20 Buller, C. R. Pleasant Mount, Wayne County, Penn.
- '12 Buller, G. W. Pleasant Mount, Wayne County, Penn.
- '19 Bullock, Charles A. U. S. Bureau of Fisheries, Bullochville, Ga.
- '17 Burkhart, Joe Big Rock Creek Trout Club, St. Croix Falls, Wis.
- '07 Burnham, Charles W. U. S. Bureau of Fisheries, Louisville, Ky.
- '25 Burnham, John B. 233 Broadway, New York City.
- '20 Buschmann, L. C. Franklin Packing Co., 3102 Smith Bldg., Seattle,
Wash.
- '17, '22 Canfield, H. L. U. S. Fisheries Station, Homer, Minn.
- '25 Carpenter, M. S. Missoula, Montana.
- '23 Catt, James District Inspector of Hatcheries, R. R. 1., St. John,
New Brunswick, Canada.
- '07 Catte, Eugene Catte Fish Hatchery, Langdon, Kansas.
- '18 Chamberlain, Thomas Knight U. S. Fisheries Station, Fairport,
Iowa.
- '17 Chambers, E. T. D. Department of Colonization, Mines & Fisheries,
Quebec, Canada.
- '25 Christianson, William State Fish Hatchery, St. Paul, Minnesota.
- '18 Christoffers, H. J. U. S. Fisheries Service, 1217 L. C. Smith Bldg.,
Seattle, Wash.
- '11 Clark, H. Walton Steinhart Aquarium, Golden Gate Park, San
Francisco, Cal.
- '23 Claybaugh, D. K. Coleman Lake Club, Goodman, Wis.
- '21 Clemens, Dr. Wilbert A. Pacific Biological Station, Nanaimo,
British Columbia, Canada.
- '00 Cobb, Eben W. 195 Walcott Hill Road, Wethersfield, Conn.
- '04 Cobb, John N. College of Fisheries, Univ. of Washington, Seattle,
Wash.
- '04 Coker, Dr. Robert E. Univ. of North Carolina, Chapel Hill, N. C.
- '13 Coles, Russell J. Danville, Va.
- '25 Colley, Josh State Fish Hatchery, Emigrant, Montana.
- '19 Commerford, William Milebrook Hatchery, R. F. D. 6, Boonville,
N. Y.
- '22 Cook, Frank Albany County Hatchery, Box 605, Laramie, Wyo.
- '17 Cook, Ward A. U. S. Bureau of Fisheries, Duluth, Minn.
- '24 Coolidge, Charles A. 122 Ames Building, Boston, Mass.
- '25 Corfman, Frank M. State Fish Hatchery, Harrisville, Mich.
- '21 Corson, Alan 127 City Hall, Philadelphia, Penn.
- '24 Corson, R. H. 2814 Boulevard., Jersey City, N. J.
- '18 Coykendall, Edward 22 Ferry St., Kingston, N. Y.
- '21 Craig, Samuel 398 Van Norman St., Port Arthur, Ontario, Canada.
- '13 Crandall, A. J. Ashaway Line & Twine Co., Ashaway, R. I.
- '11 Crasser, Hugo U. S. Bureau of Fisheries, La Crosse, Wis.
- '25 Crile, Dr. George 2620 Derbyshire Road, Cleveland, Ohio.
- '25 Cruikshank, J. H. 3120 Federal St., El Paso, Texas.
- '25 Cuenin, J. P. San Francisco Examiner, San Francisco, Calif.
- '08 Culler, C. F. U. S. Bureau of Fisheries, Homer, Minn.
- '23 Curtis, Brian C. 125 East 57th St., New York City, N. Y.
- '25 Cuyler, George A. State Fish Hatchery, Harrisville, Mich.

- '12 Danglede, Ernest Vevay, Indiana.
- '06 Davies, David U. S. Fisheries Station, Put-in-Bay, Ohio.
- '23 Davis, Dr. H. S. U. S. Bureau of Fisheries, Washington, D. C.
- '91, '10 Dean, Prof. Bashford Columbia Univ. New York City, N. Y.
- '01 Dean, Herbert D. U. S. Bureau of Fisheries, Charlevoix, Mich.
- '24 Dence, Welford A. New York State College of Forestry, Syracuse, N. Y.
- '25 Decozen, Alfred 1226 Broad St., Newark, N. J.
- '25 Delgado, T. P. Santa Fe, New Mexico.
- '19 Denmead, Talbott 2830 St. Paul St., Baltimore, Md.
- '23 Dennig, Louis E. 3817 Choteau, St. Louis, Mo.
- '08 Detweiler, John Y. Florida Fish Commission, New Smyrna, Fla.
- '24 Dickinson, William E. Public Museum, Milwaukee, Wis.
- '12, '23 Dilg, Will H. 538 Lake Shore Drive, Chicago, Ill.
- '23 Dillon, Horace State Fish Hatchery, Story, Wyo.
- '99 Dinsmore, A. H. U. S. Bureau of Fisheries, St. Johnsbury, Vt.
- '25 Doellner, Fred H. 267 E. Wabasha Street, Winona, Minnesota.
- '09 Doyle, Henry 101 Winch Bldg. Vancouver, B. C., Canada.
- '23 Doze, J. B. State Fish Hatchery, Pratt, Kansas.
- '20 Dryfoos, Leon 508 State St., Erie, Penn.
- '23 Duncan, Charles W. U. S. Bureau of Fisheries, Tupelo, Miss.
- '00 Dunlap, Irving H. U. S. Bureau of Fisheries, Washington, D. C.
- '24 Earle, Swepson Conservation Commission, Baltimore, Md.
- '23 Edmondson, Claude L. U. S. Bureau of Fisheries, Neosho, Mo.
- '13 Embody, Dr. George C. Tripphammer Road, Ithaca, N. Y.
- '21 Emerich, Walter G. R. F. D. 1, Watervliet, N. Y.
- '23 Engelhardt, Fred U. S. Bureau of Fisheries, Washington, D. C.
- '17 Erickson, C. J. P. O. Box 1446, Boston 2, Mass.
- '20 Evans, H. R. Cultus Lake Hatchery, Vedder Crossing Post Office, British Columbia, Canada.
- '06 Evans, Lieut.-Col. Kelly Metropolitan Club, New York City, N. Y.
- '04 Evermann, J. W. Supervisor of Public Utilities, Dallas, Texas.
- '25 Evers, Ade President Izaak Walton League, Nashville, Ark.
- '24 Fabyon, Francis H. 72 Franklin St., Boston, Mass.
- '25 Faye, James J. P. O. Box 1618, Denver, Colo.
- '18 Fearnow, E. C. U. S. Bureau of Fisheries, Washington, D. C.
- '23 Feusted, John G. U. S. Fisheries Station, Homer, Minn.
- '20 Fiedler, Reginald H. 310 East 51st St., Seattle, Wash.
- '07 Field, Dr. George W. Sharon, Mass.
- '04 Fisher, John F. Black Rock Trout Hatchery, Chapinville, Conn.
- '20 Fleming, John H. Columbia City, Indiana.
- '04 Follett, Richard E. 2134 Dime Bank Bldg., Detroit, Mich.
- '14 Forsyth, Robert 1157 The Rookery, Chicago, Ill.
- '10 Foster, Frederick J. Chief of Hatcheries, State of Missouri Fish and Game Dept. Westover, Mo.
- '25 Fox, Howard A., State Fish Hatchery, Harrisville, Mich.
- '24 Frantz, Horace G. 14 Alsace Way, Colorado Springs, Col.
- '22 Frazer, Dr. C. McLean University of British Columbia, Vancouver, Canada.
- '18 French, Albert International Agri. Corporation, 61 Broadway, New York City, N. Y.
- '18 Fridenberg, Robert 22 West 56th St., New York City, N. Y.
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- '21 Department of Conservation New Orleans, La.
- '22 State Conservation Commission of Maryland 512 Munsey Bldg., Baltimore, Md.
- '21 Department of Conservation of Massachusetts State House, Boston, Mass.
- '24 Parvin, Hon. R. G. Commissioner, State Game & Fish Commission, Denver, Colorado.
- '21 Department of Game & Fish of Minnesota Old State Capitol, St. Paul, Minnesota.
- '21 Oregon Fish Commission 1105 Gasco Bldg., Portland, Ore.
- '23 Wisconsin Conservation Commission Madison, Wisconsin.
- '25 New Jersey State Fish & Game Commission, Trenton, N. J.

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